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L1: Entry 10 of 13

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**\*\* See image for Certificate of Correction \*\***TITLE: Communication control device for controlling the flow of data between a plurality of devicesAbstract Text (1):

In a system made up of a plurality of devices such as a copier, an RDF, and a sorter, there is provided in each device a communication control device for providing communication between devices such that communication between devices can be performed independently of the device control unit inherent to that device. The communication control device includes data storage for storing device control data which can be accessed at random by a device control unit, access storage for storing access data indicating that the data storage is accessed, and a communication device for transmitting and receiving data stored in data storage. A synchronization storage device sets synchronization data indicating that the device control unit has set all the data to be transmitted in the data storage and synchronizes the device control unit and each communication control device on the basis of the synchronization data. Each communication control device further includes a protocol control device for controlling the communication device and the data storage such that any data stored in the data storage is read out and is transmitted and such that the data received by the communication device is stored at a predetermined in data storage means. In addition, the protocol control device controls the access storage device and the synchronization storage device.

Brief Summary Text (3):

The present invention relates to a communication control device for exchanging data between a plurality of devices by a communication link.

Brief Summary Text (11):

(1) The communication control program must be activated at appropriate time intervals to allow the device control program for a copier or the like to be securely executed. In consequence, exchange of data in the copier system is delayed, and it takes a long time for the microprocessor to receive and confirm the response to the transmission data required to control a device. This prevents any attempts to increase the productivity of the copier system.

Brief Summary Text (14):

In view of the above-described problems of the related art, an object of the present invention is to provide an improved communication control device.

Brief Summary Text (16):

Another object of the present invention is directed to providing for highly accurate system control in a system comprised of a plurality of devices.

Brief Summary Text (17):

Another object of the present invention is to provide a communication control device which is capable of reducing or preventing delay in the exchange of data between devices and ensures highly accurate device control by performing communication control independently of the control of a single device.

Brief Summary Text (18):

These and other objects of the present invention are obtained in a system comprising a plurality of devices which communicate with each other by providing each of the devices with a dedicated communication control unit. This enables communications between the devices to be performed independently of the device control inherent to the device. The communication control unit includes a data storage area which may be accessed at random, an access storage flag for indicating that the data storage area has been accessed, a communicator for transmitting and receiving data, a synchronization storage device for synchronizing a host, a remote device, and the data storage area, and a protocol control area for controlling the communicator and the data storage area such that arbitrary data stored in the data storage area is read out and transmitted, and such that data received by the communicator is stored at a predetermined area in the data storage area. The protocol control device further controls the access storage flag and the synchronization storage device. In this way, communication is performed independently of the device control inherent in each device, and highly accurate and high speed system control is ensured.

Drawing Description Text (2):

FIG. 1 is a cross-sectional view of a system to which a communication control device of the present invention can be applied;

Drawing Description Text (4):

FIG. 3, comprising FIGS. 3A and 3B, is a circuit diagram of a control device of the system of FIG. 1;

Drawing Description Text (6):

FIG. 5 is a block diagram of an (Intelligent Protocol Controller (IPC), showing an internal configuration thereof;

Detailed Description Text (22):

The sorter 400 has a tray with 25 bins 411. It has the function of piling or sorting the sheets of recorded paper. There are three sorter operation modes, a non-sorting mode, a sorting mode and a collation mode. The sorter 400 operates in the operation mode selected before a copy start key 605 of a display/operation unit 600 of the copier 100 is pressed (all of which are described below).

Detailed Description Text (24):

In the non-sorting mode, the bin shifting motor 420 does not operate after sorting has started, hence the bins do not shift. As a result, the copy sheets are sequentially discharged by the paper discharge rollers 229 of the copier body and the non-sorting paper discharge rollers 407 into the top tray. An accommodation display 430 is provided at the non-sorting paper discharge port.

Detailed Description Text (29):

FIG. 2 shows the layout of an operation panel provided on the copier body 100. The operation panel has a group of keys 600 and a group of displays 700 which are described below.

Detailed Description Text (44):

F. Group of Displays (700)

Detailed Description Text (45):

In FIG. 2, a reference numeral 701 denotes an LCD (liquid crystal) type message display which displays information on copying using characters each of which is composed of 5.times.7 dots, e.g., a 40-character textual message or a copy reproduction ratio set by the reduction and enlargement keys 608 and 609, the direct copy key 610 and the variable reproduction ratio keys 617 and 618. The display 701 employs a semitransmission type liquid crystal and two colors for back lights, normally the back light of green being lighted whereas the back light of

orange being used for-abnormal messages or in a copy disabled state.

Detailed Description Text (46):

A reference numeral 706 denotes a direct copy display which lights up when a direct copy is selected. 703 designates a color developing unit select display which lights up when a sepia developing unit is set. 702 denotes a copy number display which displays a copy number or a self-diagnosis code. 705 denotes a cassette display which displays whether the upper stage cassette 151, the intermediate stage cassette 153 or the lower deck 201 is selected.

Detailed Description Text (47):

704 denotes an AE display, which lights up when AE (automatic density control) is selected by pressing the AE key 613. 709 denotes a standby mode display which lights up in the preheated state. The display 709 blinks in the automatic shut-off state. 707 denotes a ready/wait display which employs a two-color LED. The display 707 lights up in green in the ready state (a state where copying is possible) and in orange in the wait stage (a state where copying is impossible).

Detailed Description Text (48):

708 designates a two-sided mode display which lights up when either a two-sided copy from a two-sided original or a two-sided copy from a single-sided original is selected.

Detailed Description Text (51):

G. Control Device (800)

Detailed Description Text (52):

FIG. 3, comprising FIGS. 3A and 3B, is a circuit diagram of a control device 800 of the copier apparatus of FIG. 1. The control device 800 includes a central processing unit (CPU) 801 for performing operations required to carry out the present invention. The CPU 801 may be a microcomputer V50 manufactured by NEC (Nippon Electric Co, Ltd.). The control device 800 also includes a read-only memory (ROM) 803 for storing control procedures (a control program). The CPU 801 controls the components connected through a bus on the basis of the control procedures stored in the ROM 803. A random-access memory (RAM) 805 is a main memory used to store input data or as a memory area for operation.

Detailed Description Text (53):

The control device 800 further includes an interface (I/O) 807 for outputting a control signal of the CPU 801 to a load such as a main motor 133, an interface 809 for sending a signal input from an image front sensor 131 or the like to the CPU 801, and an interface 811 for I/O controlling the group of keys 600 and the group of displays 700. The interfaces 807, 809 and 811 may be an I/O circuit port .mu.PD8255 manufactured by NEC.

Detailed Description Text (54):

The group of displays 700 represents the indicators shown in FIG. 2 which use LEDs and LCDs, and the group of keys 600 represents the keys shown in FIG. 2. The CPU 801 is capable of acknowledging which key is pressed by means of a known key matrix.

Detailed Description Text (55):

An IC 900 exclusively used for communications is composed of a dual port RAM 920 shown in FIG. 5, a universal asynchronous receiver/transmitter (UART) unit 930 which is capable of communicating with a plurality of other devices, a control unit 910, and so on.

Detailed Description Text (56):

The control unit 910 of the IC 900 has the function of transmitting the data stored in the dual port RAM 920 which has been modified by the CPU 801 through the UART

unit 930 and of receiving data through the UART unit 930 and storing the received data on the dual port RAM after data processing, e.g., error checking, it.

Detailed Description Text (58):

The dual port RAM 920 in the IC 900 stores the newest condition data on the operation status of the sorter 400 and the RDF 300 which has been transmitted therefrom. The CPU 801 is capable of grasping the controlled state of the sorter and the RDF by accessing the RAM.

Detailed Description Text (60):

An IC 900 exclusively used for communications (hereinafter referred to as an IPC: Intelligent Protocol Controller) is an intelligent communication control IC in which a CPU, a ROM, a RAM, 3-channel asynchronous serial interface, a BUS interface are fabricated on one chip. The IPC 900 has the function of automatically transmitting data on the RAM and of setting the received data on the RAM.

Detailed Description Text (61):

As shown in FIG. 5, the IPC 900 includes a control unit 910 for controlling the IPC internally, a dual port RAM unit 920, a UART (Universal Asynchronous Receiver/Transmitter) unit 930 for performing a communication control, and a BUS interface unit 940 used to connect the IPC with an external (host) device.

Detailed Description Text (62):

910: (Control Unit)

Detailed Description Text (63):

The control unit is composed of a single chip CPU 911 with a ROM and a RAM incorporated therein, a timer X 912 for performing timing control, and a port 913 for an external memory.

Detailed Description Text (79):

LINEERR outputs pulses having a duration of about 6 .mu.s when a communication line error (a parity error or a framing error) occurs on either of channel 1, 2 and 3.

Detailed Description Text (121):

Errors generated by communication line fall into parity errors, checksum errors and framing errors. Errors may also be generated by data loss due to excessive communication, resetting of a destination IPC, and power off.

Detailed Description Text (134):

Upon receipt of a transmission request, the IPC detects the position at which the updated data is stored in the Tx block, and transmits the data located at the area ranging from the uppermost address to the lowermost address as a packet. In this way, data can be communicated efficiently.

Detailed Description Text (154):

In this embodiment, an error is processed in the master device (the copier body) of the system in the manner shown in FIG. 29. That is, if the error is not automatically recovered by the IPC within 200 ms after the occurrence thereof, the flow goes to the system error processing. At this time, a display displays the fact that a system error is occurring. Further, three errors which occur within the passage of 1 second also generate a system error.

Detailed Description Text (155):

Further, when the communication line is disconnected on the transmission side, the IPC does not in principle set error status. Accordingly, no error status is generated in the master device when the transmission line of the master device is disconnected. However, this causes a timeout error to be generated on the receipt side. In consequence, a slave device (the RDF or sorter in this embodiment) generates a timeout error, and if the IPC does not automatically recover from the

error within a preset time interval (within 200 ms in a case where the device is operating and within 5000 ms in a case where the device is not operating, as shown in FIG. 30), the communication baud rate of the IPC is switched over so as to allow an error to be generated in the master device (the copier body in this embodiment) and a system error to be displayed (see FIG. 30). The above-described master-slave relationship is distinct from the master-slave relationship employed for communications and is adopted only for error processing.

Detailed Description Text (157):

As will be understood from the foregoing description, data communications are controlled in a system according to the invention independently of the control of the relevant devices. This prevents delay in the exchange of data, and ensures highly accurate system control.

CLAIMS:

1. A communication control apparatus, comprising:

a first control means for controlling a device;

a data storage means accessed at random by said first control means;

a communication means for performing communication of data with another apparatus; and

a second control means for controlling said communication means to transmit data stored in said data storage means into said another apparatus in accordance with an update of data in said data storage means performed by said first control means.

7. A communication control apparatus according to claim 1, wherein said data storage means and memory means in said another apparatus have a plurality of storage regions, further comprising:

an access storage means, corresponding to each of said plurality of storage regions, for storing a presence of an access to said each of said plurality of storage regions; and

wherein said second control means is adapted to transmit the data stored in said plurality of storage regions and accessed on the basis of the presence of an access stored in said access storage means.

8. A communication control apparatus according to claim 7, wherein all the contents of said access storage means are returned to an absent state of an access after said communication means has transmitted the data.

9. A communication control apparatus according to claim 1, wherein said data storage means and memory means in said another apparatus have a transmission region for storing data to be transmitted and a reception region for storing received data, and said second control means is adapted to transmit the data stored in said transmission region within said data storage means into said reception region within said memory means, or to receive the data stored in said transmission region within said memory means into said reception region within said data storage means.

10. A communication control apparatus according to claim 9, further comprising:

an operation means for operating the data stored in said data storage means; and

wherein said communication means is adapted to receive a result of an operation on data stored in said reception region within said memory means at every

predetermined interval, and to transmit the data stored in said transmission region within said data storage means into said reception region within said memory means when a result of an operation data stored in said transmission region within said data storage means is different from a result of an operation data stored in said reception region within said memory means.

12. A communication control apparatus according to claim 1, wherein said communication means includes a temporary storage means for temporarily storing data, said communication means being adapted to transmit the data stored in said data storage means to said another apparatus after storing data in said temporary storage means, and said communication means further being adapted to resend the data stored in said temporary storage means to said another apparatus when said detection means detects an error of communication.

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L1: Entry 11 of 13

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Oct 20, 1992

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TITLE: Image data control system for image reading equipmentAbstract Text (1):

An image data control system for use in an image reading equipment, in which analog signals output from a line sensor, which represent the amounts of light reflected from an original sheet are converted into digital signals by analog/digital conversion, and then the digital signals are converted into density signals to obtain original sheet reading signals in the form of the density signals, the system characterized in that offset control are performed by an offset control circuit and dark time output adjustment by the unit of picture elements are performed by a dark time correction circuit, respectively, after performing gain control by a gain control circuit.

Brief Summary Text (3):

The present Invention relates to an image reading equipment for digital copying machines, facsimile machines, or the like and more particularly to a data control system which, being used for an image reading equipment, develops the signals representing the image on the original sheet in terms of density signals, converting the analog signals obtained by reading, by means of its sensor, the amount of the light reflected from the original sheet into digital signals, and thereafter transforming the said digital signals into density signals.

Drawing Description Text (2):

FIGS. 1(a) and 1(b) are schematic diagrams illustrating one embodiment of the image data control system according to this invention for use in the image reading system.

Drawing Description Text (20):

FIGS. 19(a) through 19(c) are charts illustrating an example of the installation of the UI with a display unit used for it.

Drawing Description Text (26):

FIGS. 25(a) through 25(c) are charts for explaining an example of the construction of the display screen.

Detailed Description Text (19):

(III-3) Control system for stepping motor

Detailed Description Text (21):

(III-5) Control system for IIT

Detailed Description Text (27):

The color copying machine to which this Invention is applied is formed with the base machine 30, i.e. the basic constituent unit, which is composed of a platen glass plate 31, which carries the original sheet thereon, an image input terminal (IIT) 32, an electrical control system container 33, the image output terminal (IOT) 34, and a paper tray 35, and a user interface (U/I) 36 and also, as optional items, of an editing pad 61, an automatic document feeder (ADF) 62, a sorter 63, and a film projector (F/P) 64.

Detailed Description Text (28):

Electrical hardware is necessary for performing the control of the IIT, IOT, U/I, etc. mentioned above, and these hardware items are the IIT and those installed separately on a plural number of boards for each of the processing units, such as the IIT, IPS, which performs the image-forming process for the output signals from the IIT, U/I, F/P, and so forth, and these are accommodated further in the electrical control system container 33, together with the SYS board performing the control of these, and the MCB board (the Machine Control Board) for controlling the IOT, the ADF, the sorter, and so forth.

Detailed Description Text (32):

The U/I 36 is designed for use by the user for making the selections of the desired functions and for giving instructions regarding the conditions for the execution of the selected functions, and this system is provided with a color display unit 51 and a hardware control panel 52 installed by the side of the said display unit, and it is further combined with an infrared ray touch board 53, so that instructions can be given directly with the "soft buttons" on the screen. Next, a description is made of the optional items for the base machine 30. One of them is the editing pad 61, which is an input device based on a system of coordinates and, when it is to be placed on the platen glass plate 31, permits the editing of various types of images by means of an input pen or a memory card. Moreover, the base machine 30 is so designed as to accept the installation of the existing ADF 62 and the existing sorter 63.

Detailed Description Text (36):

This Invention has a major characteristic feature in its offer of a full automatic system covering the entire copying process from the inlet of copying work to the exit thereof while providing fully variegated and multifarious functions dealing adequately with the users' needs and at the same time producing a system which everybody can operate with ease owing to such features as the selection of the functions, the selection of the executing conditions, and the display of other items on the menu, which are put on display on the CRT screen, etc. in the user interface mentioned above.

Detailed Description Text (53):

This function is applicable to documents, and consequently the original sheets are treated as black-and-white original sheets, the images within the specified area being restored to the palette colors on the CRT and the areas other than the specified one being rendered in black on the copy. In the black and red mode, moreover, the image is changed into red while the areas other than the specified area is rendered in black and red on the copy. This function are accompanied with the trimming, masking, color mesh, black-to-color functions. Furthermore, the specification of the area is done either by drawing a closed loop on the original sheet or by specifying the area by means of the editing pad. The same procedure applies also to the specification of the area for processing in each of the editing functions mentioned hereinbelow. Additionally, the area so specified is displayed in an analogous figure in the bit map area on the CRT.

Detailed Description Text (90):

With touching operations on the pathway tab for the pathway region on the soft panel, it is possible to open the pathway and to select the various types of editing functions. In the marker editing function, for example, it is possible to perform the editing and processing of documents in black and white, using the tool called the marker, and, in the business editing function, high-quality original documents can be produced quickly mainly for use as business documents. Moreover, in the creative editing function, various types of editing functions with many choices are made available in such a manner that this copying machine will be able to satisfy the needs of various specialists, such as designers, copying service agents, and key operators. In addition, the area specified by the editing functions

is put on display in the form of a bit map area, so that the specified area can be ascertained thereby. Thus, such abundant editing functions and color creation capabilities of this system make it possible to achieve very considerable enhancements of the power of expression in writings.

Detailed Description Text (92):

This Invention has achieved the materialization of a highly efficient four-color full-color copying machine with the power consumption of 1.5 kVA. For this purpose, a decision has been made on a control system in such a way as to realize the power consumption of 1.5 kVA in each of the operating modes, and the distribution of electric power to the individual functions has been decided so as to set the target values. Furthermore, an energy system table has been compiled in order to ascertain the channels for energy transmission, and the system is so designed for its control and verification by the energy systems.

Detailed Description Text (101):

In case a color CRT is used as a user interface (UI) as is the case with the present system, the amount of data will be increased because of the color displaying features as compared with the case where a monochromatic display is used, and also there will be an increase in the amount of data if it is attempted to construct a friendlier UI by incorporating therein contrivances regarding the composition of the display screen and the transition of the screens.

Detailed Description Text (108):

Furthermore, each of the individual remote units shown in the Figure is composed of a single board. In this Figure, moreover, the bold solid line represents the LNET high-speed communication network at 187.5 kbps, and the bold broken line indicates the master/slave system serial communication network at 9,600 bps, while the slender solid line indicates the hot line, which is the transmission channel for the control signals. Also, the line marked 76.8 kbps in the Figure is the exclusive-purpose transmission line for use in the issuing of notices of the information on the images drawn on the editing pad, the information on the copying modes as input from the memory card, and the graphic information in the editing area from the UI remote unit 70 to the IPS remote unit 74. Furthermore, what is marked CCC (Communication Control Chip) in the Figure is the integrated circuit (IC) which supports the protocol for the high-speed communication line LNET.

Detailed Description Text (110):

The UI remote unit 70 is composed of the LL UI (Low Level UI) module 80 and the module (not shown in the Figure) which performs the processing operations with respect to the editing pad and the memory card. The LL UI module 80 is the same as what is ordinarily known as the CRT controller, and thus it is a module for displaying the screen on the color CRT, and hence it is controlled by the SYS UI module 81 or the MCB UI module 86 what picture image screen is to be put on display from time to time. It should be evident from this that this architecture makes it possible to develop the UI remote unit for common use with other models or other equipments. The reason is that the CRT controller is to be used together with the CRT although it differs from one model to another what a screen composition should be used and how the transitions of the screens should take place.

Detailed Description Text (114):

Moreover, the IIT remote unit 73 accommodates the IIT module 84, which performs the control of the stepping motor used for the imaging unit, and the IPS remote unit 74 accommodates the IPS module 85, which performs the various processing operations concerning the IPS, and these modules are controlled by the SYSTEM module 82.

Detailed Description Text (146):

That is to say, the LNET is available by the contention system, by which the individual nodes in the SYS remote unit 71, the MCB remote unit 75, and so forth transmit signals when they desire to and, should there occur any collision of data,

transmit the data again after the passage of the prescribed duration of time. Thus, if the SYS remote unit 71 conducts any CCC self-test while any other node is using the LNET, there occurs a collision of data, so that the self-test cannot be conducted. Therefore, when the SYS remote unit 71 begins any CCC self-test, the LNET test by the MCB remote unit 75 is already completed.

Detailed Description Text (149):

During the power-on sequence mentioned above, there may be a failure in responding to the demand for the self-test results or there may occur an abnormal condition in the self-test results, in which case the MCB remote unit 75 renders the machine dead and, putting the UI controlling authority in action, the said remote unit controls the UI remote unit 70 and puts on display a message to the effect that an abnormal condition has taken place. This is the machine dead state.

Detailed Description Text (151):

When the initialize state is completed, the individual remote units enter into their standby state, in which they are ready for operation. Even in this state, the SYS remote unit 71 still holds the UI mastering authority, and therefore the SYS remote unit 71 puts the F/F on the UI screen on the basis of the UI mastering authority, thereby entering into the state in which it is ready to accept the copy executing conditions. At this time, the MCB remote unit 75 is monitoring the IOT. Moreover, the MCB remote unit 75 issues the background pole once in every 500 m seconds to the SYS remote unit 71, in response to which the SYS remote unit 71 performs the process of returning the self-test results once in every 200 m seconds to the MCB remote unit 75. In case the self-test results are not returned or in case there is any abnormal condition in the contents of the self-test results at this stage, the MCB remote unit 75 gives the UI remote unit 70 a notice to the effect that an abnormal condition has taken place and causes the UI remote unit 70 to display a message to that effect.

Detailed Description Text (152):

When the Auditron is put into operation in the standby state, the system enters into the Auditron state, in which the MCB remote unit 75 performs the Auditron control operation and also controls the UI remote unit 70 to make the said unit display a message for the Auditron. When the start key is pushed, with the F/F set, in the standby state, the system enters into the progress state, which is divided further into the six states of setup, cycle up, run, skip pitch, normal cycle down, and cycle down shut down, and these states are explained below with reference to FIG. 8.

Detailed Description Text (154):

When the SYS remote unit 71 detects that the start key has been pushed, the said remote unit 71 transmits the particulars of the job to the IIT remote unit 73 and the IPS remote unit 74 and also issues the particulars of the job, together with a command called "the Start Job Command" to the copier executive module 87 located in the MCB remote unit 75. This puts the machine into the setup state, and the individual remote units make preliminary preparations for their performance of the jobs assigned to them respectively. For example, the IOT module 90 performs such jobs as the driving of the main motor and a proper adjustment of the parameter for the photosensitive material belt (i.e. the photo receptor belt). When the SYS remote unit 71 ascertains that the ACK (Acknowledge), which is a response to the Start Job Command, has been sent back, the said remote unit 71 makes the IIT remote unit 73 perform the prescanning operations. There are four types of prescanning operations, namely, the prescanning operation for detecting the size of the original sheet, the prescanning operation for detecting the color in the specified position on the original sheet, the prescanning operation for detecting the closed loop in case an outline drawing is to be processed for coloring, and the prescanning operation for the reading of the marker in the marker editing process, and, depending on the selected F/F, the system performs the prescanning operations up to three times in the maximum. While the prescanning operation is being

performed, the UI puts on display such a message as "Please wait a moment!". When the prescanning operation is completed, the system issues the command, "IIT Ready," to the copier executive module 87, and, at this point, the system enters into the "cycle up" state. This "cycle up" state is the one in which the system waits for the elapse of the building up time for the individual remote units, and the MCB remote unit 75 begins the operations of the IOT and the image transfer device, and the SYS remote unit 71 initializes the IPS remote unit 74. At this moment, the UI displays the message that the system is in the progress state, as well as the particulars of the selected job.

Detailed Description Text (160):

In the event that any fault occurs in the progress state, the system moves on to the fault recovery state. The term, "fault," is a general designation of such abnormal conditions in the machine as the absence of paper, jamming, and any failure or breakage of any component part, and there are two types of faults, one type consisting of those faults from which recovery can be made by the users by taking such steps as the resetting of the F/F but the other type consisting of those faults from which recovery can be attained only by the serviceman by such measures as the replacement of some component parts. As mentioned above, the displaying of faults is performed basically by the MCB UI module 86, but, since the F/F is controlled by the SYS module 82, the recovery from any of those faults which are correctable by the resetting of the F/F is to be performed by the SYS mode 82 while the recovery from all the other faults is to be executed by the Copier Executive Module 87.

Detailed Description Text (165):

The faults of this type include, for example, a trouble in the registering sensor, an abnormal condition in the speed of the imaging unit, an overrun of the imaging unit, an abnormal condition in the PRO signal, an abnormal condition in the CCC, an abnormal condition in the serial communication network, and an error in checks on the ROM or the RAM, and, in the case of these faults, the UI will display such a message as "Please call the Serviceman!" as well as the particulars of the fault.

Detailed Description Text (175):

Now, assume that entry has been made by the prescribed operating procedure into the TECH REP mode by the route A shown in the Figure from the standby route in the customer mode. The TECH REP mode can be finished after simply having done the setting of the various kinds of checks and the setting of the parameters in this mode, and, to return to the customer mode (by the route B in the Figure), it is possible to move into the power-on state as shown in FIG. 6, by performing the prescribed key operation, and then return to the standby state by following the sequence indicated in FIG. 7. However, since this copying machine performs color copying and that it is also provided with a variety of editing functions, it is necessary to ascertain through the actual copying performance, after the setting of the various parameters is completed in the TECH REP mode, whether or not the copying machine can really reproduce the colors as required by the users and whether or not the machine can perform editing functions as specified. It is the Customer Simulation mode that performs this task, and this mode is different from the customer mode in the point that this simulation mode does not execute any billing job and that this mode displays a message to the effect that the machine is being operated in the DIAG. state.

Detailed Description Text (251):

In the case of the reduction process, the system writes the data in the line buffer 3083 while processing the said data for complementation thereof and, at the same time, transmits the data processed for reduction for the preceding line, reading the said data out of the buffer. In the case of the enlargement process, the system once writes the data as they are and at the same time transmits the data for the preceding line while processing the said data for complementation for enlargement. Although the complementation and enlargement process performed at the time of

writing the data would make it necessary to increase the clock in proportion to the enlargement ratio for the time when the writing process is performed, the design of the process described above permits the writing/reading of the data with the same clock. Moreover, with this construction, it is possible to process the shift image in the main scanning direction by reading the data from a point in the middle of the sequence or reading the data with a delay in timing, and it is possible to perform the repeating process by reading the data in repetition, and it is also possible to perform the mirror image processing by reading the data in the reverse direction.

Detailed Description Text (298):

(A) Adoption of color display

Detailed Description Text (299):

FIG. 19 is a chart illustrating the state of installation and the external view of the user interface system built by the use of a display unit while FIG. 20 is a chart for describing the angle and height of installation of the user interface.

Detailed Description Text (302):

With a view to making improvements on the important feature, the operating facility of the equipment, the user interface for this Invention is provided with a 12-inch color display unit 501 and with a hardware control panel 502, which is positioned by one side of the said display, as illustrated in FIG. 19.

Detailed Description Text (303):

Furthermore, a menu easy to view and easy to comprehend is offered to the users through integration of features reflecting contrivances for displays in color, and additionally an infrared ray touch-board 503 is combined with the color display unit 501, which allows the user to gain direct access to the system with operations on the "soft buttons" on the screen. Moreover, the particulars of the operations are distributed for efficiency to the "hard buttons" on the hardware control panel 502 and the "soft buttons" put on display on the screen of the color display unit 501, and this feature has made it possible to simplify the operations and to achieve an efficient composition of the menu screen.

Detailed Description Text (304):

On the back sides of the color display unit 501 and the hardware control panel 502 are mounted the monitor control/power source board 504, the video engine board 505, the CRT driver board 506, and so forth, as shown in FIGS. 19 (b) and (c), and the hardware control panel 502 is set at an angle for directing the said control panel 502 further towards the center than the face of the color display unit 501 as shown in FIG. 19 (c).

Detailed Description Text (305):

Moreover, the color display unit 501 and the hardware control panel 502 are installed not directly on the base machine 507 (i.e. the main unit of the copying machine) but on the supporting arm 508 set up on the base machine 507. The adoption of a color display unit 501 thus mounted on a stand, without the adoption of a console panel as in practice with the conventional copying machines, makes it possible to install the color display unit in a position above the base machine 507 in a three-dimensional arrangement as illustrated in FIG. 20 (a), and, therefore, by arranging the color display unit 501 in the right innermost position above the base machine 507 as illustrated in FIG. 20 (a), it is possible to design a copying machine without giving consideration to the console panel, which in turn makes it possible to design such an equipment in a compact size.

Detailed Description Text (306):

In a copying machine, the height of the platen, which in effect corresponds to the height of the equipment, is designed to measure up to the waist height, which is quite convenient for setting the original sheets, and this height places

limitations on the height of the equipment. The conventional console panels are installed in the uppermost position of copying machines and they are consequently positioned almost at the height of the operator's waist and thus in the neighborhood of the hands, which permits easy access to the panel for performing operations thereon, but this means that the operating panel section, which is to be used for the selection of the functions and the setting of the executing conditions, and the display section are positioned in a place at a distance quite remote from the eyes. In this respect, the user interface for this Invention is installed in a position higher than that of the platen, i.e. at a level significantly closer to the height of the eyes, as shown in FIG. 20 (b), and this arrangement offers greater ease in looking at the display and also provides greater ease in operation since its position is not at a lower level but in the forward direction as viewed by the operator. In addition, the height set for the installation of the display unit at a level close to the height of the eyes makes it possible to utilize the space below the display unit effectively as a space for the installation of such optional kits as the control board, the memory card device, and the key counter. Therefore, this design approach renders it unnecessary to make any structural change for the installation of a memory card device, and thus it is possible to install a memory card device as an additional item without making any change in the external appearance of the equipment, and, at the same time, it is possible to set the position and height for the installation of the display unit in such a way as to ensure ease in viewing. Moreover, it goes without saying that the display unit may be installed rigidly at a prescribed angle, but may also be set in a construction adopted to permit the changes in the setting angle of the said unit.

#### Detailed Description Text (309):

The construction of the modules for the user interface of this copying machine is composed of the video display module 511, which controls the image screens put on display on the color display unit 501, as shown in FIG. 21, the editing pad 513, and the editing pad interface module 512, which performs the processing of the input and output for the memory card 514, and the systems UI 517 and UI 519, the sub-system 515, the touch screen 503, and the control panel 502, which perform control over these modules and pads, are connected to the video display module 511.

#### Detailed Description Text (310):

The editing pad interface module 512 accepts the input of the coordinates, X and Y, from the editing pad 513 and also the input of the jobs and the coordinates, X and Y, from the memory card 514, and it also transmits the video map display information to the video display module 511 and exchanges the UI control signals with the said video display module 511.

#### Detailed Description Text (312):

The video display module 511 recognizes the button ID data with reference to the input points as input for the vertical side and the horizontal side of the touch screen 503 (i.e. the positions of the coordinates on the touch screen) and inputs the button ID data for the control panel 502. Then, this module 511 transmits the button ID data to the systems UI 517 and UI 519 and receives the demand for display from the systems UI 517 and the UI 519. Moreover, the sub-system (ESS) 515 is connected, for example, to work stations and the host CPU, and thus it is the printer controller when this copying machine is used as a laser printer. In such a case, the information generated with the touch screen 503, the control panel 502, and the keyboard (not illustrated in the Figure) is transmitted as it is to the sub-system 515, and the contents on the display screen are transmitted from the sub-system 515 to the video display module 511.

#### Detailed Description Text (314):

(C) Construction of display screen

Detailed Description Text (316):

FIG. 23 is a chart illustrating the construction of the UICB. In the UICB, the CPU 534 (for example, a CPU equivalent to 8051 by Intel Corp.) is provided in addition to the CPU's mentioned above, and, with CCC 531 being connected to the data communication lines, such as the high-speed communication line LNET and the optional keyboard, the CPU 534 and the CCC 531 together control the communications, and the CPU 534 is employed also for the driving of the touch screen. The signals generated on the touch screen, as they are, i.e. in the form of the information on the positions of the coordinates on the said screen, are taken into the CPU 532 from the CPU 534 through the CCC 531, so that the signals are processed by the CPU 532 for the recognition of the button ID data. Moreover, the UCIB is connected to the control panel through the input port 551 and the output port 552, and the UCIB is also designed to be capable of performing the transmission and reception of commands and the status information at the rate of 9,600 bps, receiving the video data at 1M bps, together with the clock signal at 1M Hz, from the EPIB 522 and the sub-system (ESS) through the sub-system interface 548, the receiver 549, and the driver 550.

Detailed Description Text (317):

As regards memory devices, the UICB is provided with the frame ROM's 538 and 539, the RAM 536, the bit map RAM 537, and the V-RAM 542 in addition to the boot ROM 535, which accommodates the boot strap. The frame ROM's 538 and 539 are memory devices which store the data for the display screen not in any bit map but in a data structure which allows easy handling by software, and, when a demand for display comes transmitted through the LNET, image drawing data are first generated here by the CPU 532 using the RAM 536 as the work area, and the data are written in the V-RAM 542 by DMA 541. Also, the bit map data are transmitted and written to the bit map RAM 537 from the EPIB 522 by the DMA 540. The character generator 544 is for use for the graphic tiles, and the text character generator 543 are for use for character tiles. The VRAM 542 is controlled with reference to the tile codes, which are composed of 24 bits (three bytes), 13 bits being used for the information on the kinds of tiles, two bits for the information for making distinction among texts, graphics, and bit maps, one bit for the blinking information, five bits for the information on the colors of the tiles, and three bits for the information on the background or the fore-ground, respectively. The CRT controller 533 develops the display screen on the basis of the tile code information written in the VRAM 542 and transmits the video data to the CRT through the shift register 545, the multiplexer 546, and the color palette 547. The drawing of images in the bit map area can be changed over by the shift register 545.

Detailed Description Text (319):

(D) Construction of display screen

Detailed Description Text (320):

Also in the adoption of a display unit for a user interface, the offer of information matching the integration of multiple functions will necessarily indicate a proportionately larger amount of information, for which it is estimated in simple perception that a more extensive display area should be necessary and that it is, in some respect, made difficult to deal adequately with the needs for a display in a compact area. If a display unit in a compact size is employed, it will be difficult to present all the necessary information on one screen, not merely because of the problems associated with the density of display, but also from the viewpoint of offering a display screen easy to view and intelligible to the operator.

Detailed Description Text (321):

For the user interface according to this invention, a display unit in a compact size is employed and yet contrivances have been made for the display on its screen and for its control within the framework of the said unit. Particularly, through effective utilization of the merit that a color display unit, as compared with the

LED's and liquid crystal indicators used in console panels, are capable of adopting a rich variety of displaying modes with the control of hues, luminance, and other displaying attributes, various contrivances have been put into the system in order to display the information in an easily understandable manner in spite of the compact size of the display unit.

Detailed Description Text (322):

For example, contrivances have been made to compose the display screens in a concise form by classifying the information to be displayed on the screen into major categories for their respective display on a plural number of screens and also, with a single screen taken as the unit, presenting the minimum of the necessary information on the primary screen with the details of information relegated to the pop-up type displays. And, with the screens which represent a plural number of information items thereon, contrivances have been made to develop characteristic features in the color indications and characteristic features in the emphatic indications so as to make it possible easily to recognize and to distinguish the necessary information on each screen.

Detailed Description Text (324):

FIG. 25 is a chart illustrating an example of the composition of the screen on the display unit, and FIG. 25 (a) is a chart showing the composition of the basic copying screen while FIG. 25 (b) is a chart showing an example of the pop-up screens put on display on the basic copying screen, and then FIG. 25 (c) is a chart showing the composition of the screen for Paint 1 for the creative editing process.

Detailed Description Text (325):

In the user interface for this Invention, the basic copying mode screen shown in FIG. 25, which is used for setting the copying modes, is put on display as the initial menu screen. The screen for setting the copying modes forms a "soft" control panel, which is a screen divided into two parts, i.e. between the message area A and the pathway B, as shown in FIG. 25.

Detailed Description Text (326):

The message area A occupies the area equivalent to three lines in the uppermost area on the screen, the first line being used for the state message and the second line and the third line forming an area for use for guiding messages in case there is any contradiction in the selection of the functions, for use for messages concerning any abnormal state of the equipment, and for use for messages representing warning information, and the prescribed messages are put on display in this area. Moreover, the right-hand margin of the message area A is assigned to the area for indicating the number of sheets, and here the set number of sheets to be copied as input with the ten keys and the number of copies being produced are indicated.

Detailed Description Text (327):

The pathway B constitutes the area where selection is to be made of various kinds of functions, and it has the pathways of basic copying, editing features, marker editing, business editing, free-hand editing, creative editing, and tools, and, in correspondence to each of these individual pathways, the pathway tabs C are put on display. Additionally, each of the pathways is provided with pop-up menus for improving the operating ease and efficiency. In the pathway B, the system puts on display the "soft" button D, which forms a list of branched choices, with which selection is to be made of the functions by touching on the appropriate button, the icon E (picture), which changes, depending on the selected function, and represents the specific function, the indicator F, which indicates the reduction/enlargement ratio, and so forth. Those functions which are shown on the pop-up menus by operations on the "soft" buttons D are indicated by the pop-up mark G ".DELTA.". And, by touching on the pathway tab C, the pathway can be opened, and the functions of the particular pathway can be selected by touching on the "soft" button D. The

selection of functions by touches on the "soft" button D is so designed in consideration of its operating efficiency that the operation are to be performed from the upper left part of the screen towards the lower right-hand side thereof in regular steps.

Detailed Description Text (328):

As mentioned above, the display system features the division between the basic copying screen and the rest of the screens in order to provide the maximum compatibility with the other models of equipment and the maximum compatibility with the hardware console panel, and the editing screen, moreover, is designed to have a hierarchical structure composed of a plural number of levels so as to offer screens and functions in a manner suitable for the operator's skill level. Furthermore, this system offers a set of screens enabling the operator to use the functions with ease in a highly variegated way with the advantage of the pop-up representation of high-level functions and complicated functions among those presented on a given single screen through the combination of the screen composition as described so far and the pop-up functions.

Detailed Description Text (330):

When the pathway tab for creative editing is touched upon in the basic copying screen, the screen for the pathway for creative editing appears by a shift of the screen on display, and it is FIG. 25 (c) that illustrates the screen for Paint 1 in that particular pathway. On this screen, there are the bit map area H and the inductive message area I. The bit map area H occupies the upper left-hand part of the screen, and this area is designed to produce its indication of the bit map in black and white when the editing area is specified, for example, on the editing pad. In addition, the inductive message area I uses the lower left-hand part of the screen, and the message performs the function of inducing or guiding the user in correspondence to the editing job, and it changes in accordance with the particular job being performed. On the screen, the area excluding these areas, i.e. the bit map area H, the inductive message area I, and the message area A in the upper region of the screen, is used as the work area.

Detailed Description Text (332):

The pathway for the basic copying function is provided with soft buttons (i.e. branched choices) for the selection of the individual functions for the color mode, paper selection, reduction and enlargement, copy quality, color balance, and job program, as illustrated in FIG. 25 (a), and is also provided with the individual pathway tabs for marker editing, business editing, free-hand editing, and creative editing, as well as aided features and tools. These pathways are the initial-phase pathways, which are put on display, for example, after the power-on operation or after turning on the all-clear button, or when the auto-clear button is turned on.

Detailed Description Text (335):

The reduction and enlargement function permits the choices of 100% reproduction, the AMS, which is to be used for setting the magnification for copying on the basis of the paper size and the original sheet size when the paper size is selected, and the voluntarily chosen magnification, and puts the set magnification, the computed magnification, or the automatic setting on display on the indicator in the top area of the equipment. For the variable magnifications, this system permits the setting of magnification by one percent in the range from 50% to 400% and also permits the setting of the vertical magnification and the horizontal magnification independently of each other (differential magnification). Therefore, the detailed setting items for these are developed on the pop-up menu. Moreover, the default magnification setting is 100%.

Detailed Description Text (342):

The copy output pathway offers the branched choices between the output of the copied paper to the top tray and the output of such paper in the sorting mode. The default choice is the output to the top tray, and, in case the sorter is not

installed, this item is not put on display. The copy sharpness pathway provides the branched choices of the standard sharpness, the manual copy sharpness control offering the functions for control in seven steps with operations on the pop-up menu, the processing of letters (characters), the print processing, the processing of photographs classified into photographs/characters, with operations on the pop-up menu, and the IPS performs control over these processes. The default choice can be set voluntarily.

Detailed Description Text (345):

The page programming pathway gives access to the branched choices of the covering function, which puts cover on the copies, the inserting function, which inserts white paper or color paper between copies, the color mode, which sets the color mode for each page of the original sheets, the tray selecting function, by which the tray can be selected for each page of the original sheet. In this regard, this item will not be put on display unless the ADF is installed.

Detailed Description Text (354):

The user interface performs constant monitoring on the status of execution of the copying operations and, in the event of the occurrence of any jamming, the interface puts on display a screen matching the particular type of jamming. Moreover, for the setting of the functions, the user interface provides an information screen corresponding to the screen currently put on display, the said information screen being kept in a state ready for display as appropriate.

Detailed Description Text (355):

For the display on the screen, moreover, the system employs a tile indication measuring 3 mm (8 pixels) in width and 6 mm (16 pixels) in height, to the exclusion of the bit map area, and this indicating area contains 80 tiles in its width and 25 tiles in its height. The bit map area is displayed with 151 pixels on its vertical side and with 216 pixels on its lateral side.

Detailed Description Text (356):

In the user interface for this invention as described so far, it is designed to change over the screens on display for each of the categories of modes, such as basic copying, aided features, and editing, and to permit the specification of the branched choices and the input of the data for the executing conditions by touching operations on the soft buttons, with the menus for the selection of the functions and the setting of the executing conditions put on display in each of the modes. In addition, depending on the types and nature of branched choices on the menu, the system provides the pop-up displays for the items indicating their details by pop-up displays (overlapping displays or window displays) in an effort to achieve the repletion of the contents offered on the display. As the result of these features, the display screen can be presented in a neat and well-organized form, which makes it possible to achieve greater ease and higher efficiency in operation, even though there may be many functions available for selection and many conditions for setting.

Detailed Description Text (358):

The hardware control panel is installed on the right side of the color display unit, at such an angle as positions the said panel more in the direction looking towards the center than the display screen. as illustrated in FIG. 20. This control panel is mounted with the individual buttons for the operations for the ten keys, ten-key clear, all clear, stop, interrupt, start, information, auditor, and language.

Detailed Description Text (364):

The information button is composed of the ON-button and the OFF-button, which are in the state ready to accept operations thereof except in the process of execution of the copying job. When the ON-button is pushed, the system indicates the information screen for the screen on display at this moment, and the OFF-button is

used to retract the information screen.

Detailed Description Text (366):

The language button is the one which is operated for the time when the language on the screen on display is to be changed to another. Therefore, the system is designed to have data in a plural number of languages for each screen put on display, so that they may be selected voluntarily.

Detailed Description Text (376):

To the right of the convex lens 617 is provided a correcting filter automatic exchanger provided with each of a correcting filter holding member 618, which, for example, supports a correcting filter 635 for adjusting the film density of 35 mm negative film and positive film (the correcting filter for one of these types of film is shown in the figure), a driving motor 619 for this correcting filter holding member 618, the first and the second position detecting sensor 620 and 621, which detect the rotating position of the correcting filter holding member 618, and the controlling unit, which controls the driving motor 619 (which is provided in the F/P 64 but not shown in the figure). And, this correcting filter automatic exchanger makes automatic selection of the correcting filter 635 matching the film 633 for the original sheet, out of the correcting filters 635 supported on the correcting filter holding member 618, and sets the said filter in its properly aligned use position on the same axis with the individual lenses, such as the projector lens 610. The correcting filter 635 for this correcting filter automatic exchanger can be positioned at any point, for example between the platen glass 31 and the imaging unit 37, so long as it is on the axis of rays for the projected light.

Detailed Description Text (390):

The F/P 64 is designed to be capable of automatically changing these correcting filters. The change of the correcting filters is performed by the correcting filter automatic change device, as mentioned above. That is to say, the microprocessor (the CPU) in the system (SYS) remote unit outputs a two-bit command signal for setting the correcting filter in proper correspondence to the film 633 for the original sheet in the position for use, and the control device, then, drives and controls the driving motor 619 in such a way that the two-bit signals from the first and the second position detecting sensors 620 and 621 come into agreement with the signal output from the CPU. Then, when the signals from the sensors 620 and 621 come into agreement with the signal from the CPU, the control device makes the motor 619 to stop. When the motor 619 has stopped, the correcting filter suitable for the film for the original sheet is automatically set in the position for its use.

Detailed Description Text (398):

The light emitter 623 emits light when the keys on the display for the U/I 136 are operated to set the system in the F/P mode, and also the AF device is put into an operatable state when the AF/MF changeover switch of the F/P 64 is set for the selection of the AF, as shown in FIG. 26. When the film case 607 containing the original sheet film 633 is set on the F/P 64, as shown in FIG. 29, the light emitted from the light emitter 623 will be reflected by this film 633 for the original film, and the reflected light is detected, for example, by the two-element type light receptor 624 for the AF.

Detailed Description Text (435):

The operation of the F/P 64 is performed mainly on the U/I 36 for the base machine 30. That is to say, the base machine 30 is set in the F/P mode by operating the F/P operation key put on display on the screen of the display unit for the U/I 36. On the assumption that the film for the original sheet is one of the three brands of film mentioned above or the registered film, there appears a message reading "Put the mirror unit in place, and then select the type of film" on the screen of the display unit for the U/I 36, as illustrated in FIG. 30. Accordingly, the first step

is to open the M/U 65 and to set it in the prescribed position on the platen glass 31.

Detailed Description Text (436):

Next, when the film selection key on the screen is pushed, the message, "Please wait without inserting the film," is put on display on the screen. At the same time, the lamp 613 is turned on, and also the correcting filter control (FC CONT) signal becomes (0, 0), and, with this, the FC operation is performed. In other words, the correcting filter automatic changing device is put into action, and the position correcting filter is set in the position for its operation. When the correcting filter is so set, the correcting filter change completion (FC SET) signal becomes LOW.

Detailed Description Text (438):

In case the reflected light does not correspond to the finite difference of 0 in the amount of the received light between the two elements of the light receptor 624, the motor 625 for the AF device is put into action, and the focus is properly adjusted thereby. In other words, the AF operation is performed. Upon the completion of the focus-adjustment, the F/P operation completely ready (F/P RDY) signal becomes LOW. After this (F/P RDY) signal becomes LOW and after the elapse of one second after the FC SET signal becomes LOW, the message, "Copying Ready," is indicated on the screen. When the start key on the U/I 36 is pushed, the message, "Copying," is put on display on the screen and also the lamp 613 is turned on, and, after the passage of the building up time for the lamp 613, the collection of data for the automatic density adjustment (A/E) is started. In other words, the imaging unit 37 performs one stroke of scanning operation and reads one part or all of the projected image, in order to obtain the data for its performance of the density adjustment, the color balance adjustment, and the .GAMMA. correction, and so forth.

Detailed Description Text (439):

Next, the copying job is performed, with the imaging unit 37 performing the scanning operation four times if for copying in full color. In such a case, the shading correction and the density adjustment are performed automatically on the basis of the shading data and the automatic density adjustment data. When the copying job is completed, the lamp 613 is turned off and, at the same time, the message, "Copying Ready," is put on display on the screen. Accordingly, a new copying job will be performed when the start key is pushed again. If it is desired to copy another image, the frame of the film is to be changed to another. When the film frame is changed to another, the F/P RDY signal becomes HIGH and also the message, "Focusing Ready," is displayed on the screen. Then, when a new frame of the film is set, the AF operation is performed, and, at the same time, the F/P RDY signal becomes LOW and also the message, "Copying Ready," is displayed on the screen. After that, a push on the start key puts the copying process into operation.

Detailed Description Text (441):

Next, a detailed description is made with respect to the Image Input Terminal (IIT) to which the image data control system for the image reading system according to this invention has been applied.

Detailed Description Text (458):

(III-3) Control system for stepping motor

Detailed Description Text (496):

(III-5) Control system for IIT

Detailed Description Text (506):

In order to control the gain, the white color reference plate is first to be read for one line portion by means of the CCD line sensor prior to the reading of the

original sheet, and the value so read is to be converted into a digital value through the A/D converter circuit 232d, and the resulting value is to be stored in the SRAM 237b. Subsequently, the VCPU 74b takes this datum into it and detects the picture element with the maximum value for each channel, and determines the prescribed gain on the basis of its comparison of this maximum value, for example, with 200 in 256 chromatic grades. And, this gain control system sets the gain automatically by setting the digital data adequate for the gain in the A/D converter 241.

Detailed Description Text (520):

Furthermore, with regard to the setting of the .DELTA. V dark correction value, the value is written to the SRAM 235b through the shading correction circuit 235a. For this .DELTA.V dark correction process, the four-line portion of the dark time output from the CCD line sensor is taken in its offset-controlled state into the system and the average value of the said output is written to the SRAM 235b. In this case, since the offset value is to be adjusted so as to set it at approximately 10 in 256 chromatic grades, as explained above, also the .DELTA.V dark correction value will assume a value in the range from 10 to 20. Consequently, the dark time output for four lines will have "0" in the most significant bit and the immediately subsequent bit in the case of eight-bit data in 256 chromatic grades. Therefore, the average value is generated by a process for shifting the two least significant bits and the two most significant bits, as stated in the following: ##STR1##

CLAIMS:

1. An image data control system, having a light sensor, comprising:

detecting means for detecting an analog signal from said light sensor, said signal representing an amount of light reflected from an original sheet;

storing means for storing a set adjustment value in a memory means;

loading means for loading a set adjustment value during a subsequent operation of said image data control system so that a data collected from said line sensor is added with the set adjustment value to produce an adjusted value;

converging means for converging the adjusted value to a target value by modifying the adjusted value through comparison between the data collected and the target value;

gain control means for amplifying said analog signal;

offset control means, responsive to said gain control means, for performing offset control;

dark time correction means, responsive to said gain control means, for performing dark time correction;

analog/digital converting means for converting said analog signal to a digital signal; and

digital/density converting means for converting said digital signal to a density signal.

2. The image data control system according to claim 1, wherein green color decomposing signals are selected for collection of data from said line sensors.

3. The image data control system according to claim 1, comprising:

average value determining means using blue color decomposing signals in a film projector reading mode to determine an average data value of an amount of light.

4. The image data control system according to claim 1 comprising:

dark time output correction means having a first line memory for performing dark time output correction,

a shading correction means having a conversion table and a second line memory for correcting a white level of an output from said conversion table;

connection means for connecting said dark time output correction means and said shading correction means so that data is collected from one of said first and second line memories.

5. The image data control system according to claim 4, wherein said conversion table comprises a logarithmic conversion table and a through table.

6. An image data control system, having a light sensor, comprising:

detecting means for detecting an analog signal from said light sensor, said signal representing an amount of light reflected from an original sheet;

calculation means for calculating a collecting address in a platen reading mode and a film projector reading mode wherein a constant value used by the calculation means is selected according to a selected mode;

gain control means for amplifying said analog signal;

offset control means, responsive to said gain control means, for performing offset control;

dark time correction means, responsive to said gain control means, for performing dark time correction;

analog/digital converting means for converting said analog signal to a digital signal; and

digital/density converting means for converting said digital signal to a density signal.

7. An image data control system, having a light sensor, comprising:

detecting means for detecting an analog signal from said light sensor, said signal representing an amount of light reflected from an original sheet;

gain control means for amplifying said analog signal;

means for calculating an average value for use in the dark time output correction means and adopting the average value as an adjustment value including:

means for finding the average value of said analog signal by a bit shift of an added value for four lines and employing a plurality of bits below a decimal point as an address in a logarithmic conversion table for conversion of said analog signal into said density signal;

offset control means, responsive to said gain control means, for performing offset control;

dark time correction means, responsive to said gain control means, for performing

dark time correction and including means for adding the values of the dark time output for every picture element for four lines;

analog/digital converting means for converting said analog signal to a digital signal; and

digital/density converting means for converting said digital signal to a density signal.

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File: USPT

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DOCUMENT-IDENTIFIER: US 4742475 A  
TITLE: Environmental control system

Abstract Text (1):

An environmental control system for use in a greenhouse or another structure which requires the control of an ambient condition regulating element in response to a plurality of sensed parameters. The system includes a plurality of sensor elements and actuator elements, which communicate with a central control through communication interface units. In an illustrated embodiment the interface units communicate over previously installed AC power lines by frequency shift keyed signals. The interface units communicate to the peripheral control elements and the central control unit through serial digital signals. The central control maintains a protocol where, in response to operator inputs, time slots are assigned to different peripheral control elements to configure the system. Each peripheral control element is thereby addressed during its time slot and a sensor responds with data corresponding to a sensed parameter and an actuator executes a command. A unique framing character is generated by the central control at the beginning of each assigned time slot for alerting the peripheral control elements an address will next be generated and for synchronizing multiple central controls to a common time slot clock.

Brief Summary Text (3):

Control of the temperature, humidity and ambient measurements in a greenhouse, or the like, to enable the control of the environment therein can necessitate monitoring and controlling numerous sensing and control devices at various locations within the structure being controlled. Due to the large number of measurements and functions that are needed to be performed, computer based or computer compatible systems have been used to centrally control the monitoring and operating functions of an environmental control system, such as in a large buildings.

Brief Summary Text (9):

Logical control of greenhouse environmental conditions has heretofore utilized, for example, 24 volt control systems with relays and solenoids individually wired together and strung out, or a computer based equivalent system (such as a programmable controller) with dedicated wires for communication and control lines strung out and wired among all control points and sensors. These systems have proved less than adequate in terms of cost, time for installation, and ease of maintenance, repair, and update of equipment. Additionally, communication among elements of the environmental control system is restricted to a dedicated control and custom wiring. Expansion requires new wiring in an installation, and modification requires rewiring the system.

Brief Summary Text (12):

Accordingly, a general object of the invention is to provide a new and improved communication and control system which has general applicabilities to environmental control systems for structures of all kinds including, but not limited to, greenhouses.

Brief Summary Text (13):

h    e b        b g e e e f    c    e    b

e    ge

A further object of the present invention is to provide a control system which does not require dedicated or independent wires for communication.

Brief Summary Text (14):

Another object of the present invention is to permit the expansion of a control system without the necessity of installing additional wires from a control center.

Brief Summary Text (16):

Yet another object of the present invention is to provide an improved environmental control system, especially suited for use in a greenhouse, which provides for communication between one or more central controllers and one or more peripheral elements of the system utilizing the existing AC power wiring.

Brief Summary Text (18):

A communication protocol is followed where each peripheral control element is assigned a time slot of a time frame where the net master will only interrogate or command a particular peripheral control element during that time slot. This protocol provides a system which can easily be configured based on its time slot assignment such that a system is defined by the number and type of peripheral control elements assigned. The net master steps through the time slots of a frame and controls the actuators and interrogates the sensors in the order in which they have been assigned. The control cycle then repeats for the next frame and following frames until the system is reconfigured by assigning other peripheral control elements to time slots or by removing some of the elements from an assignment. Time slots which do not have a peripheral control element assigned are not used by the net master and are merely stepped over.

Brief Summary Text (20):

Additionally, the management of zones in a controlled environment is facilitated by the time slot protocol. Multiple net masters can be provided which address the peripheral control elements of different zones without interference because of the time slot separation. Alternatively, two or more net masters can control different system configurations in one zone of a controlled environment without contention by this protocol. Redundancy is advantageously provided by the system where if one net master becomes inoperative, another can pick up its load by reprogramming the time slot assignments to take into account a different configuration or zone. The new net master for a zone does not even have to be moved to take control because of its remote communication capability.

Brief Summary Text (21):

As an additional feature of the flexible system protocol, all time slot clocks are synchronized adaptively between net masters. Each transmission of a net master contains a certain unique character which is used as a framing or synchronizing character by all other net masters. When a particular time slot which has been assigned to one net master is addressed, the transmission of that net master to the peripheral control element, either being commanded or interrogated, is also received by all other net masters. By decoding the transmission after the framing character, all other net masters synchronize their time slot clocks with the unique character and thereby the transmitting net master for that time slot. For each transmission by a net master the other net masters are thereby adaptively synchronized together maintaining an overall common time slot clock.

Brief Summary Text (24):

A system control comprises a microprocessor based controller which has means for receiving operator input, means for communicating with the peripheral control elements of the sensors and actuators of a system configuration, means for displaying information to an operator, and means for controlling the system according to a predetermined control law.

Brief Summary Text (27):

This operation has an advantage where the stages can be programmed for maximizing the cooling or heating effect the farther the actual temperature is from the set point and gradually reducing the effect through different configurations and stages as the actual temperature approaches the set point. This approach not only saves energy in an environmental control system, but for a greenhouse is particularly advantageous because it reduces the thermal shock to growing plants produced by normal on-off thermostatic controls.

Brief Summary Text (28):

In a greenhouse environment, additional features provided for the control system are a provision for multiple sets points and modification of the control program either by manual overrides or special condition overrides which are sensed. For multiple temperature sets points, a photo cell which is interrogated by the system control through a peripheral control element provides information about the light level in the environment. The system uses this light level information to switch from a day temperature set point to a night temperature set point and a separately staged program. Overrides to control the openings of vents for extreme environmental conditions such as rain and wind are provided by interrogating sensors which detect such conditions with a peripheral control element. Further, the control program can be modified automatically by sensing the outdoor temperature through a suitable peripheral control element. A manual override which directly controls the positioning of the vents is additionally provided to modify the program control.

Drawing Description Text (3):

FIG. 1 is a system block diagram of an environmental control system constructed in accordance with the invention;

Drawing Description Text (4):

FIG. 2 is a pictorial diagram of a greenhouse with a plurality of peripheral elements for heating and cooling the structure which are controlled by the environmental control system illustrated in FIG. 1;

Drawing Description Text (5):

FIGS. 3a, 3b, 3c and 3d are pictorial representations of the system communication protocol for environmental control system illustrated in FIG. 1;

Drawing Description Text (6):

FIG. 4 is a front view of the system control unit for the environmental control system illustrated in FIG. 1 showing the operator control keys and displays available for interfacing with the system;

Drawing Description Text (7):

FIG. 5 is a tabular representation of a generalized control law which is executed by the system control unit to regulate the environment of a greenhouse;

Drawing Description Text (8):

FIG. 6 is a detailed electrical schematic diagram of the display of the system control unit illustrated by FIG. 1 and FIG. 4;

Drawing Description Text (9):

FIG. 7 is a detailed electrical schematic diagram of the control keys of the system control unit illustrated in FIG. 1 and FIG. 4;

Drawing Description Text (11):

FIG. 8 is a detailed electrical schematic diagram of the circuitry for the system control unit illustrate in FIG. 1 and FIG. 4;

Drawing Description Text (16):

FIG. 13 is a system flow chart of the software executed by the system control unit

illustrated in FIG. 1;

Detailed Description Text (2):

Referring now to the drawings, and particularly FIG. 1, a system implementation of the present invention is illustrated. A plurality of modular communication interface means 100, 102, 104, 106 and 108 are coupled to an AC power transmission line 110 and are additionally coupled individually to a system control unit 112, a system control unit 114, and peripheral control elements 116, 118 and 120, respectively. The communication interface means provide for bidirectional or unidirectional data communication via the power line between the control units 112, 114 and the peripheral control elements 116, 118 and 120.

Detailed Description Text (4):

The system provides a control in which a number of remote elements comprising the peripheral control elements are remotely controlled by either one or more control units. In this manner, any number of peripheral control elements can be coupled to the power line and remotely controlled by the control units. This produces a system which is very flexible in configuration and which is easily adapted for many environmental control situations. For example, for the environmental control of a greenhouse one or more zones can be assigned to a particular control unit and controlled efficiently thereby or each control unit may have a separate zone to control with a different system configuration based upon the number and types of peripheral control elements which are controlled thereby.

Detailed Description Text (8):

The interface means receive digital data from a communicating device and transform that data into a frequency shift keyed signal which can be inductively coupled to the power line 110. For those interface means that contain a transmitter, data is transferred to the interface means by a data line TxD and transmission is enabled by a transmit data signal TxEN. For the receiving function, data is transferred over the data line RxD to the communicating device after it has been converted from a frequency shift keyed signal to digital data. The system protocol and timing of the transmission and receipt of the information which may be addresses, commands, interrogations, or data will be more fully described hereinafter.

Detailed Description Text (9):

In the illustrated embodiment, each control unit performs a number of system functions. First, a control unit 112 provides a microprocessor base control system comprising a central processing unit (CPU) and associated memory coupled to an input means, such as a keyboard, and to a display means, and a communication device for transmitting digital data to the interface means 100. The control unit 112 of the environmental control system in accordance with stored program instructions and user input data performs the functions of system configuration control, task sequencing, communication linkage and protocol, system diagnostics, user interface, storage, and archiving.

Detailed Description Text (10):

The communication and timing protocol used by the system will now be more fully explained with respect to FIGS. 3a-3d. Each peripheral control element, whether controlling a sensor element or an actuator element, is enabled only in response to being addressed by one of the control units. Each control unit allocates time slots each dedicated to communication with a uniquely addressed remote element. Any number of addresses are possible with this system but a capability of 1000 is shown in the illustrated embodiment. A timing diagram illustrating the time slots is shown in the FIG. 3a where a frame of 1000 time slots is disclosed as being two minutes in length. The frame is subdivided into 10 subframes each containing 100 time slots, where each of the time slots is 120 milliseconds in duration.

Detailed Description Text (11):

Therefore, if a peripheral control element is assigned a time slot in one of the

subframes, it is addressed once every two minutes in the present scheme. Thereafter, the cycle repeats until the system configuration is changed. It is seen that by using this type of protocol that every remote element can be addressed uniquely during its time slot and further that a system can be configured merely by assigning the time slot. Further, the sequence in which the remote elements are controlled during a frame is dependent upon the time slot assigned. This provides an extremely flexible system for providing control with different configurations of elements and for sequencing the elements at different times. Thus, all remote elements have not only a physical separation by address but a time separation by the the time slots.

#### Detailed Description Text (12):

Further, in the protocol for the system is a particular transmission format for each of the control units and peripheral control elements. The nature of the transmissions is dependent upon the type of remote element being addressed. Each piece of equipment has information transmitted into it in the form of a communication data string as shown in FIG. 3b. The communication string initiates with a C/M bit group, a constant mark, which may be as long as 30 bits to be able to lock up the phase locked loop in the receiver of the addressed element. Next, there is a byte FF containing a unique word which allows the time slot clocks of the multiple net controllers to be synchronized. Thereafter, each piece of equipment has an address of the form a byte T0TP and a byte T2T1. TP is a four bit BCD prefix or function code representing the subframe and T0T1 are two four bit BCD nibbles representing the particular time slot 0-99 within a subframe. Each byte is actually eleven bits of 1 millisec/bit. This is standard asynchronous data transmission protocol where each byte is headed by a start bit and ended with a stop bit which is followed by a parity bit.

#### Detailed Description Text (13):

In the present protocol, all addresses beginning with the prefix 1 (first subframe) are vent motor controllers 116. Since there are 100 time slots within the subframe, there can be as many as 100 different vent motor controllers addressed by the system. Similarly, all addresses with a prefix 2 are indoor sensors 126 and all addresses with a prefix 3 are outdoor sensors 132. All address prefixes between 4-8 are for devices controlled by address controllers 120. FIG. 3d illustrates a table of the present prefixes and their assignments to the peripheral control elements of the present configuration. It should be readily apparent that such assignment is arbitrary and can be changed for convenience, or to order the sequencing of the peripheral control elements if necessary.

#### Detailed Description Text (14):

The information is transferred at the beginning of a particular time slot using a burst transmission. The format for the transmission to a sensor is different from that which is used for an actuator command. For an actuator, a byte D0D1 following the address byte consists of a command consisting of two nibbles. The two nibbles, D0 and D1, are used by the peripheral control element to decode a command from the data received, such as the amount of opening for a vent or which particular relay to close. For a remote sensor, the format is that as is illustrated in FIG. 3c where the control unit merely sends in burst transmission the C/M constant mark, the unique character FF, the prefix, and the address byte. This sequence forms an interrogation of a remote sensor and the peripheral control device for a sensor replies to that interrogation. Upon receipt of the transmission from a control unit, the peripheral control element of a sensor will reply with a similar constant mark C/M and two bytes of data D0, D1, D2 and D3.

#### Detailed Description Text (15):

As an example, for the particular implementation shown when the address prefix is 2, the controller sends an address without any data to an indoor sensor and waits for temperature data D0D1 and a light level D2D3 to be returned to the control unit. In a similar manner, when the prefix is 3 the controller sends the address of

an outdoor sensor to a peripheral control element. Temperature data D0D1 and rain or wind data D2D3 is then returned to the control unit immediately upon reception of the interrogation. In instances of transmission for either actuators or sensors to insure reliable data transfer the control unit repeats the transmissions five times before ending the data burst. The remote controlled elements must receive two valid identical messages in sequence before they will be accepted and acted upon.

Detailed Description Text (16):

At the end of each time slot, a control unit will select the next time slot and check to see if that slot has been assigned to the system configuration by a user. If so, it commences transmission in the formats previously described depending upon whether the time slot has been assigned to a peripheral control element which regulates a sensor or an actuator. During the initial transmission, the information is preceded by the unique word FF which serves to synchronize all remote elements and indicates that some remote element address is forthcoming. The remote element whose address follows the unique word will then take appropriate action while all others go back to waiting for another unique character before they are enabled. The unique word FF also permits all other control units not having been assigned that particular time slot a chance to synchronize their time slot clocks adaptively to the clock of the transmitting control unit.

Detailed Description Text (18):

FIG. 2 shows a structure, more particularly a greenhouse, advantageously using an environmental control system according to the present invention. The implementation shown is merely illustrative and many other remote controlled elements or different configurations could be used with the present system. The greenhouse structure 10 includes a number of ventilation structures to provide circulation of inside and outside air, including a top vent 12 and a side vent 38. Generally these vent structures are operated by a motor 22, in the case of vent 30, operating a rack 14 and pinion assembly 20. The motor rotates the pinion of the assembly 20 to position the rack 14 and open or close the vent as determined by a vent motor controller 24.

Detailed Description Text (20):

In a similar manner the vent 30 operates by means of a rack 43 and pinion assembly 42 positioning the vent between the full open position, as indicated by striking plate 44, and the full closed position, as indicated by striking plate 46. The vent motor 48 rotates the pinion of the assembly 42 to provide positioning in response to commands from a vent motor controller 40. The vent motor controller 40 receives feedback signals from the pinion assembly 42 indicating the number of teeth sensed on the pinion gear by a magnetic sensing assembly and the extreme position signals for the full open and full closed positions. As was the case for the vent motor controller 24, the vent motor controller 40 is connected to a manual control unit 36 which may override the remote signals to the vent motor controller.

Detailed Description Text (21):

A master or net control unit 34 remotely controls the two or more vent motor controllers shown in the drawing to open and close the vents according to a programmed control. In addition the control unit 34 can interrogate a number of remote sensors such as an indoor sensor 66 and an outdoor sensor 56. The indoor sensor 66 comprises a temperature sensor and a day/night sensor for indicating the light level in the greenhouse structure 10. The temperature sensor indicates the indoor or actual temperature of the greenhouse structure 10 which can be used to control that actual indoor temperature to any particular point. Another remote sensor that is interrogated by the control unit 34 is the outdoor sensor 56. The outdoor sensor 56 is coupled to a roof mounted structure including an anemometer 50 and a rain pad 52. The anemometer 50 gives information as to wind speed as an electrical signal and the rain pad transmits information as an electrical signal with respect to rain conditions via a cable 54 to the outdoor sensor 56. In addition the outdoor sensor 56 comprises a temperature sensor to give an indication

of the outside temperature conditions.

Detailed Description Text (22):

For air circulation purposes, an exhaust fan 28 is used in combination with an address controller 32. The address controller 32 is adapted to switch the fan motor 30 on and off according to instructions from the control unit 34. The exhaust fan 28 may be used in combination with either heating or cooling means and the vents to produce an increase or a decrease in the indoor temperature of the greenhouse structure 10. Normally, several exhaust fans for a particular zone of a greenhouse will be controlled in this manner.

Detailed Description Text (23):

Generally, the cooling means are embodied as a cooling pad 58 through which water is circulated by a pump 60 fed by conduit 62. The pump 60 is remotely actuated by means of an address controller 64 which is under control of the central control unit 34. Turning on the cooling pad motor 60 allows water to circulate through the cooling pads and by evaporation provides an air conditioning effect for the inside of the greenhouse structure 10.

Detailed Description Text (24):

Additionally, a heating unit 68 is supplied to raise the ambient temperature when needed. The heating unit 68 includes a blower motor 70 for exhausting heated air through a controllable louver structure 76 which directs the heated air flow. In addition a gas valve 72 may be proportionally opened to provide the fuel for burning needed to heat the air. These devices are remotely actuated by address controller 74 which is under the supervision of the central control unit 34.

Detailed Description Text (25):

In a programmed sequence having different stages and temperature set points, the vents, exhaust fans, and cooling pads may be used to reduce the temperature in the greenhouse structure. The vents, exhaust fans, and the heating unit can be used to increase the temperature in the greenhouse structure 10. The indoor sensor 66 allows a switch from two temperature programs on the basis of whether the light level indicates a day or night condition in the structure. In addition the indoor sensor 66 provides a signal for indicating the actual temperature of the structure. The outdoor sensor may provide wind and rain overrides for the particular program executed by the central control unit 34 or a modification of that program because of outdoor temperature.

Detailed Description Text (26):

The peripheral control elements of the greenhouse environmental control shown in FIG. 2 communicate over the existing AC power lines shown schematically as connections 11. It is evident that other devices could additionally be included in this control and that more than just one or two of each device could be used. For example, if a number of vents or exhaust fans are to be used together, although they have different physical peripheral control elements, they can be operated simultaneously by assigning the devices the same address or time slot in the protocol. Each peripheral control element communicates with the control unit 34 over the AC power lines as described previously to provide an integrated environmental control for a greenhouse. Further, it should be noted that the equipment shown will allow control of only one zone for a greenhouse. Of course, similar zones could be set up by duplicating the equipment shown and controlling them with either the control unit 34 illustrated or another net master.

Detailed Description Text (27):

The operator input means and the display of information to the operator for the control unit 34 are more fully disclosed in FIG. 4 where the front panel of the control unit is illustrated. A key pad is used for the entry of information and has touch sensitive keys for numerical inputs 0-9 and for sixteen function inputs. A reset key is provided to clear an entire program of the control unit out of memory

and a clear key is provided to zero a particular entry out of the memory.

Detailed Description Text (28):

Other keys allow the input of the program variables into the memory of the control unit 34. For example, to enter the address programming, the address key 212 is pressed and then a series of two digit numbers are entered upon request from the display 200 until all peripheral elements have been assigned addresses or time slots. At that point the address key is again pressed and the address entries are closed. The operator can assign any of the addresses 0-99 for any remote element depending on its prefix. Only one address, however, is assigned to any one element unless it is to act in parallel with another. To proofread the entries, the display key 232 is pressed in combination with the address key 212. The display 200 in response to this keyed request sequence produces the programmed addresses in sequence and numerical order. Input of the starting time for a real time clock is produced by pressing the enter key 230 and then the time key 220. Thereafter, four digits can be entered for hours and minutes and either the AM or PM keys 208 and 210 are pressed.

Detailed Description Text (30):

The same sequence is produced for entering the data for the remaining stages until the programming for all day stages has been accomplished. As was the case for the addresses, the stage temperatures may be proofread by pressing the display key 232, the day key 226, the set point key 222, and the temperature key 214. With this sequence the entry in the memory for the day set point may be determined. Additional temperature set points for any stage can be determined in a similar manner. If the memory must be altered after the display, the clear key can be pressed and the variable reprogrammed as described previously.

Detailed Description Text (31):

Following the entry of the addresses for the peripheral elements and the program temperature stages, the actual elements are assigned to the stages by another entry process. The operator presses the enter key 230, the day key 226, the stage key 226, a digit indicating the stage desired, and then the data key 218. The display responds with an address request to which the operator replies with the numerical keys in three digits. The display then requests either the percentage that a particular vent should be open or whether the actuated element of an address should be on or off. The display then calls for the address of the next device and the operator enters information as to the percentage opening or whether the device is to be on or off.

Detailed Description Text (32):

The process continues until all the elements for a particular stage have been entered and then the process is repeated for all the remaining day stages. The entries may then be proofread by pressing the display key 232, the day key 226, and the stage key 224 with an identifier number and the data key. Incorrect entries can be removed from memory with the clear key and then reentered as described previously. The night programming may be performed in a similar manner by setting the night set point and stage temperatures and then assigning the particular elements to the stages.

Detailed Description Text (34):

In the automatic mode, the controller steps through the programs for the day and night entries controlling the elements as set forth in the sequential operation. Day to night program change is provided by the light level indication from the indoor sensor. During the automatic mode the display is in a roll over mode where particular information about the stage is being output continuously for five seconds each. The real time, set point temperature, inside and outside temperatures, and the current stage of operation are displayed. This display sequence will then be repeated until one of these parameters changes.

Detailed Description Text (35):

An example of a program and the operating conditions for each element in a program of seven stages is shown in FIG. 5. The ideal temperature of a structure at any given time is known as the set point and is the temperature boundary for stage zero of the control. Thereafter, temperature is controlled in stages or bands which can be of any temperature range desired. For each temperature band or stage, the percentage of vent opening and all remote on/off and proportional control functions are determined thereby fully configuring the system for each stage. Whenever the temperature rises above or falls below a stage temperature, the system begins operating all of the equipment which is assigned to the new stage. A built in delay avoids excessive cycling of the equipment as the temperature passes through the stage thresholds. Light levels are metered by the indoor sensor and determine whether the control unit operates in either the day or night program. The day program can be run during the night or the night program can be run during the day by either covering the photocell developing the light level control signal or by shining a light on the photocell as needed. It is also possible to adjust the threshold of the light sensor so that during dark cloudy periods when photosynthesis is not occurring the control unit will switch to the night mode and reduce the use of energy by the control elements.

Detailed Description Text (37):

Referring to FIGS. 6 and 7 the front panel illustrated in FIG. 4 is shown in a detailed schematic form. The display comprises two parts which are a keyboard portion shown in FIG. 7 and a display portion shown in FIG. 6. The display as illustrated in FIG. 6 is used to drive eight 7-segment displays 310, 314, 318, 322, 336, 340, 344, and 348, along with their decimal points 312, 316, 320, 324, 338, 342, 346 and 350. In addition, light emitting diodes 302, 304, 328 and 330 are controlled for producing indications of an automatic mode, a manual mode, and for PM or AM indications, respectively.

Detailed Description Text (38):

The display elements are driven by two identical display driver chips 300 and 326. Each display driver chip, for example the one referenced 300, contains a brightness circuit including resistor 306 and capacitor 308 which couples between the power supply input +V of the driver device 300 and the brightness terminal BRT. Display driver 326 has a similarly connected circuit comprising resistor 332 and capacitor 334. Depending upon the values of the resistors and capacitors, the brightness of the particular display is controlled by the amount of current that is drawn through its elements.

Detailed Description Text (39):

The display driver devices also include an enable input EN, a data input DATA, and a clock input CLK. Serial data in digital form is provided on the communication line DAT1 to the data input DATA and is clocked into the driver device 300 by means of a clock signal CLOCK when the device is enabled with an enable signal ENABLE. The central processing unit of the system control outputs the serial data words to the device 300 over the DATA1 line which are applied to the outputs B1-B34 to light those particular elements in the display which have a logical one in their bit position. Those elements which have a logical zero in their bit position of the transmitted word are not lighted. Similarly, the central processing unit communicates with the device driver 326 via the enable signal ENABLE, the clock line CLOCK, and a data line DATA2. The displays are updated when necessary by the program to display the addresses, set points, stages and the peripheral control element assignments.

Detailed Description Text (40):

In FIG. 7, the keyboard connections for the display unit are illustrated. The keyboard comprises a 4.times.4 matrix including lines 376-382 which form inputs Y1-Y4 for the central processing unit and lines 384-390 which form inputs X1-X4 for the central processing unit. The central processing unit can strobe the inputs X1-

X4, Y1-Y4 to determine the continuity between two lines because of the pressing of a key. The keys displayed indicate those matrix points which are connected together for a particular character or command. For example, lines 376 and 384 are connected by pressing push button 370 to indicate the numeral 1. Further, those lines are connected together to indicate a DISPLAY command with push button 372 or an ENTER command with push button 374. The particular lines which have continuity are decoded by the central processing unit into the particular character or command. For more than one character or command, the sequence of the entry determines the decoding process in the control unit.

Detailed Description Text (42):

Referring now to FIG. 8 an electrical schematic diagram of the system control unit is illustrated. A central processing unit (CPU) 400 performs the keyboard and display interface functions in accordance with a stored program and provides communication to the peripheral control elements. In the illustrated embodiment the microprocessor 400 may be a model 8035 microprocessor manufactured and commercially available from the Intel Corp. of Santa Clara, Calif.

Detailed Description Text (43):

The program for the control of the system is provided in an EPROM 404 and a random access memory 406 is included for storing intermediate variables, flags, and the operator program for control of the system. The processor 404 has a multiplexed address and data bus D0-D7 and thus requires the utilization of an address latch 402 to prolong the address outputs while placing data signals on the bus. The EPROM 404 is addressed by twelve digits including the eight bits supplied by the Q0-Q7 outputs of the address latch 402 and four bits supplied by the port 2 pins, P20-P23. Upon enablement of its output enable and chip enable terminals OE, CE, respectively by a program store enable signal PSEN from the microprocessor 400 the EPROM 404 outputs an instruction onto the data bus. The microprocessor 400 receives the instruction via the data bus 401 and executes the instruction to perform a program cycle.

Detailed Description Text (45):

The inputs from the keyboard X1-X4, Y1-Y4 are read by the microprocessor into the port 1 inputs P10-P17. The port 1 lines P10-P17 are able to read the bit inputs from the keyboard display indicating which lines are connected together by individual keys. Outputs for control of the display by the microprocessor 400 are port 2 lines P24-P27. P24 applies the clock signal CLOCK to the display while lines P25 and P26, respectively output serial data for the DATA1, DATA2 signals, respectively. Line P27 applies the signal ENABLE at the correct times to produce a display under program control of the microprocessor 400.

Detailed Description Text (49):

To send a data byte over the power lines the microprocessor 400 first selects the USART device 416 with the chip select input CS and thereafter brings the write line WR low and outputs the data byte on the data bus D0-D7. This will cause the USART 416 to receive the data byte and load it into a holding register for transmission. The microprocessor 400 can by writing a command over the data bus cause the stored data byte to be transmitted via data line TxD. For receiving data, the USART 416 inputs the data via the RxD input asynchronously into a holding register until the microprocessor 400 is ready to receive that data. Upon a command generated by bringing the RD output of the microprocessor 400 to a low level, the USART device 416 will place the received data byte on the data bus for input to the microprocessor. The transmission protocol of the USART 416 is such that during transmission a start bit, stop bit and a parity bit are added to the eight bits of a data byte. Additionally, upon reception these bits are stripped from the data by the USART 416 before being input to the microprocessor 400.

Detailed Description Text (50):

With reference now to FIG. 9 there is shown a detailed schematic diagram of

circuitry implementing a vent motor controller such as the one shown as 116 in FIG. 1. The vent motor controller comprises a microprocessor based controller which communicates with a system control unit via an interface comprising a communication device including a receiver 464 and a USART 460. Since the vent motor controller only receives commands just a receiver is required for the communication interface. Digital data is received by the USART 460 from the communication interface via its Rx/D input. The USART 460 receives a clock from the T0 output of the microprocessor 416 as a 1.024 MHz signal. As previously described this clock signal can be divided by a divide by 16 counter 462 before being applied to the receive clock and transmit clock inputs RxC, TxC, respectively. This produces a clock for reading in serial digital data from the receiver 462 which has decoded the frequency shift keyed information from the power line 458.

Detailed Description Text (52):

This data is an address indicating whether this particular vent is being commanded and a command byte indicating the percent opening for the vent if it is the one selected. The address sent from the control unit is matched against an address input to the microprocessor 466 from terminals P20-P23. The address for the particular vent can be set by a pair of thumb wheel switches 472 and 470 which input two BCD digits to terminals P50-P53 and P60-P63, respectively of an I/O expander device 468. The I/O expander device 468 has its input terminals P20-P23 connected to the terminals P20-P23 of the microprocessor 466 and when strobed with a PROG signal are able to transfer the BCD digits from the thumb wheel devices.

Detailed Description Text (53):

In general, the microprocessor 466 controls the vent through a signal OPEN generated on line 490 from P16 and a signal CLOSE generated on line 488 from P17 of the microprocessor 466. By knowing the position of the vent and by applying a CLOSE or OPEN signal for a predetermined time, the microprocessor 466 can position the vent at any desired % opening. The microprocessor 466 senses the position of the vent via inputs to its T1, P15, and P26 terminals. The input to T1 is from a magnet sensor via input line 494 and a pull up resistor 492. The magnet sensor produces a ground signal upon the passage of a magnet in the pinion gear by the sensor. In addition, a limit switch 500 is connected to input P15 via a pull up resistor 502 and produces a ground on P15 when the limit switch is closed by hitting a striking plate. A switch 498 is connected to P26 via pull up resistor 496 and produces a ground level signal when the striking plate of the rack hits it indicating the vent is fully open. These three signals, whether the vent is fully open, fully closed, or has a magnet signal, provide information to the microprocessor 466 about the actual position of the vent. The microprocessor thereafter modifies this information in accordance with the command given by the control unit over the power line to position the vent. In addition, the microprocessor 466 receives a signal via line 486 to input P27 from a torque sensor to indicate a torque overload on a vent motor. If a torque overload is sensed, then the microprocessor 466 includes programming to protect the motor and to light a torque overload LED 484. The LED 484 is connected between a source of positive voltage +V and output P15 via resistor 482. The microprocessor by producing a low level signal on output P15 can activate the LED 484.

Detailed Description Text (55):

FIG. 10 illustrates a schematic electrical diagram for a remote sensor controller such as the one referenced as 118 in FIG. 1. A number of remote sensors may be interrogated for their parameter inputs by this controller. A microprocessor 504 communicates directly with a control unit via a communication interface 506 including a transmitter and receiver as previously described. The transmitter/receiver 506 converts digital data from the microprocessor 504 into frequency shift keyed data for transmission over the power line 508 and decodes frequency shift keyed data from the power line into digital data for the microprocessor 504. Serial data is received by the microprocessor 504 via the Rx/D line and is input to terminal T1 of the device. Serial data is transmitted from the

microprocessor via output P17 over transmission line TxD with a transmit enable signal TxEN from output P24.

Detailed Description Text (64):

The microprocessor 602 receives the commands from a central control unit and generates a plurality of on/off control signals via its data bus D0-D7. These on/off control signals are transmitted to a corresponding group of driver inverters 614 one of which is illustrated as 616. The driver inverter 614 produce a inversion and current amplification of the output signal for driving the coil of a relay. Each of the drivers is attached to relays 618-632 which have switch outputs K1-K8, respectively. Each of the relays is similar and only one will be described for exemplary purposes such as the one labeled 618. The output of the driver 616 is applied to one terminal of the relay coil 636 whereas the other terminal of the relay coil is connected to a coil voltage source +Vh. A diode 634 is placed between the two terminals of the coil 636 to provide a path for the flyback pulse when the relay is switched off.

Detailed Description Text (67):

Additionally the microprocessor 602 of the address receiver controller can provide for a proportional control based upon commands received over the power lines. This implementation will be provided when the prefix is set at 8. Pins P35-P38 of port 3 of the microprocessor 602 connect to the input of inverting NAND gates 644-650, respectively. The outputs of the NAND gates are tied commonly to one terminal of a resistor 652 whose other terminal is connected to a source of positive voltage +V. The common junction of is further connected to the base of a NPN transistor 660 through two diodes 654 and 656. The transistor 660 is connected as a common emitter amplifier with a collector resistor 658 tied to a power supply +Vh. The output of the amplifier, at the collector terminal, is connected to a filter circuit comprising resistor 662 and a group of parallel capacitors 666, 668 and 670. Operationally, the microprocessor 602 by generating different digital words through port 3 on pins P35-P38 provides a variable drive to the base of transistor 660 which produces a voltage on the collector which is filtered through the resistors and capacitors of the output. By varying the digital word, a proportional voltage output from terminal 672 can be provided to a controlled device.

Detailed Description Text (71):

The voltage controlled oscillator 722 produces one of two frequency tones depending upon the digital input of the microprocessor on the transmit line TxD and transmit enable line TxEN. The voltage controlled oscillator 722 outputs a frequency dependent upon the current input from a current matrix comprising switches 724 and the value of a timing capacitor 726, and a network of timing resistors 728. The present configuration allows four different frequencies to be output. The frequencies are selected by the two digital inputs from the ready to transmit enable line TxEN and the transmit data line TxD. The digital inputs from these lines are amplified by common emitter amplifiers comprising NPN transistors 730 and 732 with collector resistors 734 and 736, respectively. Base resistors 738 and 740 are supplied with a positive bias voltage +V which normally produces conduction from the transistors on a 00 digital input to the current switches 468.

Detailed Description Text (76):

A detailed description of the software program executed by the microprocessor 400 of the control unit will now be more fully set forth with respect to the flow chart of FIG. 13. After the hardware timer clock is enabled in Block A10, the program begins by calling an initialization routine INITIAL in block A12. During the initialization routine, the addresses as for the equipment used are accepted and stored in memory. After the initialization has been accomplished, the program continues by calling the subroutine KEYPAD in block A14 which is responsible for scanning the keypad. The parameters related to the key bounce properties of the pad are accommodated by portions of the subroutine. The keypad routine buffers those active keys for further handling in subsequent routines.

Detailed Description Text (77):

Next, the program calls the time slot routine TSL0T in block A16 which produces an interrogation of the remote sensor controllers and commands the peripheral control elements including the vent motor controllers and address receiver controllers. Thereafter, the subroutine, the receiver routine RX is called in block A18. RX is a general purpose receive data handler for interface with the USART device. When data is ready for the microprocessor, this routine places a received data byte into a particular location of the RAM memory. The subroutine monitors transmissions of any other net masters which may be present on the network and continuously updates the time slot synchronization for the control unit in concert with those transmissions.

Detailed Description Text (78):

Subsequently, a display handler routine DSPHLR is called in block A20 which directs the display as to which information is shown. The display handler routine DSPHLR is a combination of subroutines which are selected by placing their labels in a particular RAM locations and then calling the routine DSPHLR. Next in the sequence, the subroutines TSL0T and RX are again called in blocks A22 and A24. Thereafter, a key handler routine KEYHLR is called in block A26. This routine is a sequence of instructions which handles the key stroke sequencing as the operator inputs the commands. It decodes these key strokes into different commands which are used by the other various routines to change the data stored for programming the peripheral control devices into a control program and for general operation of the system. FIG. 7a was used to illustrate the valid key sequences and routines used for this operation. In block A28 and A30 the subroutines TSL0T and RX, respectively, are called for the third time in the loop.

Detailed Description Text (79):

The microprocessor 400 then tests a pin on one of its ports which is coupled to the rectified output of the main power supply. By decoding whether this port pin is at a high or low level the system may determine whether it is being supplied an AC power from its normal power supply or from a battery backup. In block A32 this test is made and, depending upon the result, the program will transfer control either to block A34 or block A36. If the AC power is not on, then block A34 produces the storage of a constant in a memory location which is read by the display routine. The entry of the constant into memory causes that routine to blank the display and conserve power.

Detailed Description Text (80):

After the execution of block A34, or if an affirmative response was the result of the test in block A32, the program calls the display routine DISPLAY in block A36. This routine provides a serial data stream compatible with the display module shown in FIG. 6. Eleven bytes of RAM are dedicated to providing the necessary source data. As mentioned previously, on finding the battery backup indicator in memory, the display is blanked and a standby power indicator enabled on the display. The program continues in block A38 and A40 by once more calling the subroutines TSL0T and RX, respectively.

Detailed Description Text (81):

It is seen that the time dependent routines TSL0T and RX which are used for communication purposes between the central control unit and the peripheral control elements are called periodically. The sequence envisions a non time dependent routine such as KEYPAD, DSPHLR, KEYHLR, or DASPLA being called and thereafter the subroutines TSL0T and RX called before the next non-time dependent routine. This alternation of the time dependent routines with the non-time dependent routines provides a facile manner for maintaining the system control in real time without a complicated interrupt structure.

Detailed Description Text (82):

The main loop constantly repeats the sequence while the system is in operation thereby keeping communications from the central control unit current through the use of the subroutine TSLOT and the information received from other net masters current with the subroutine RX. In a normal automatic operation, the system operates by stepping through the time slots while interrogating sensors or commanding actuated elements with the subroutine TSLOT and receiving messages from other net master controls with the receive routine RX. During this time the display handler routine DSPHLR is normally providing the rolling display as previously described. Only for manual operation or for a change in the programming are the KEYPAD and KEYHLR routines called.

Detailed Description Text (105):

To illustrate control of the system and operation of the MATCH program in particular, take the case where the temperature is greater than the set point ST0. What the program accomplishes is to locate the actual temperature in the range of temperatures forming the stages to determine which equipment should be actuated during that phase. A temperature A230 greater than the set point ST0 is illustrated between the boundaries of stage 4 and stage 5 in the illustration. Since the temperature is greater than the stage 4 threshold, and less than the stage 5 threshold, the the indication of the current stage number should be set to stage 4.

Detailed Description Text (112):

The subroutine for receiving data by the control until will now be more fully discussed with reference to FIG. 21. The receive subroutine is referenced as RX and is the program used by the control unit to monitor the power line for transmissions from other net masters. The routine initiates in Block A300 by determining when a new byte is received by USART Device 416. If the USART 416 has not indicated that a complete byte has been assembled for transmission to the microprocessor 400, then the program exits immediately so that other programs in the main loop may be executed. Because the receive subroutine RX is executed periodically, the operation provides a convenient method of monitoring the power line until a full byte is assembled for decoding without overburdening the microprocessor 400. When a new byte is assembled, the program transfers control to Block A302, where the byte is tested to determine if it is the unique framing character FF. If not, then the program exits immediately and only returns to this block after another new byte has been assembled.

Detailed Description Text (117):

Upon the powerup of the device, a number of functions are accomplished for calibration purposes. Initially in Block A330, the RAM is cleared to provide storage space for the variables and constants which the program generates. In Block A332, the program reads the address of the particular vent motor controller through pins P20-P23. This address is then stored and can be used by the program to determine whether a central control unit is addressing this device or some other. A calibration sequence is then started in Blocks A334-A338 where the vent is fully closed by setting pin P17 high thereby generating the CLOSE signal on line 488. The program is able to determine when the vent is fully closed by monitoring pin P15 until a ground level is found.

Detailed Description Text (130):

The program for the address receiver controller is similar to the vent motor controller where it includes an initializing portion comprising Blocks A374 and A376 and a main loop portion which is constantly executed after the powerup phase. In the initial phase, in Block A374, the RAM of microprocessor 602 is cleared and the device address read into memory in Block A376. Depending upon the jumpers set for pins P21-P24, P27-P30, and P31-P34, the address of a single actuator device, an eight actuator device, or a proportional control device will be stored in memory.

CLAIMS:

1. A control system for varying at least one controlled parameter to control the environment of a greenhouse structure with a plurality of remotely controlled elements, said control system comprising:

a programmed controller for communicating with the plurality of remotely controlled elements over an AC power line;

said programmed controller including a stored control program defining the state of operation of each of said remotely controlled elements during a plurality of parameter stages away from a set point value for said at least one controlled parameter, said control program regulating the operation of said remotely controlled elements during each stage in said defined states to move the actual value of said controlled parameter of the greenhouse toward said set point value;

means for determining the parameter stage corresponding to the actual value of said controlled parameter of the greenhouse; and

means for commanding said remotely controlled elements to operate in accordance with said stored program for said determined stage.

2. A control system as defined in claim 1 wherein said plurality of remotely controlled elements include:

means for heating the greenhouse.

3. A control system as defined in claim 1 wherein said plurality of remotely controlled elements include:

means for cooling the greenhouse.

4. A control system as defined in claim 3 wherein said plurality of remotely controlled elements include:

means for ventilating the greenhouse with outside air; and

means for circulating the air within the greenhouse.

5. A control system as defined in claim 1 which further include:

a vent motor controller;

a remote sensor controller; and

an address controller.

6. A control system as defined in claim 5: wherein said plurality of remotely controlled elements include a vent whose percent of opening is controlled by a motor; and

wherein said vent motor controller includes means for receiving commands from said programmed controller as to the desired percent of opening of said vent;

means for determining the present percent of opening of said vent; and

means for controlling said motor to move said vent from said present percent of opening to said commanded percent of opening.

7. A control system as defined in claim 6 wherein said vent motor controller further includes:

means for overriding said percent of opening commands in response to a manual mode signal;

means, enabled by said manual mode signal, for controlling said motor to open said vent; and

means, enabled by said manual mode signal, for controlling said motor to close said vent.

8. A control system as defined in claim 6:

wherein said vent includes means for generating pulses indicative of incremental movements of said vent,

means for generating a fully open vent signal when said vent is fully open, and

means for generating a fully closed vent signal when said vent is fully closed; and

wherein said present percent of opening determining means includes:

means for sensing said fully closed vent signal;

means for sensing said fully opened vent signal;

means for sensing said pulses;

means for generating a calibration count by counting the number of pulses between said fully opened and fully closed vent condition;

means, utilizing said calibration count, for translating said percent opening commands into a commanded number of pulses; and

said means for controlling said motor moving said vent said commanded number pulses.

10. A control system as defined in claim 5 having at least one remote sensor:

wherein said at least one remote sensor includes a sensor for measuring an actual temperature; and

wherein said remote sensor controller includes:

means for storing an actual temperature word indicative of said actual measured temperature;

means for receiving interrogations from said programmed controller; and

means for transmitting said stored temperature word to said programmed controller in response to said interrogations.

11. A control system as defined in claim 10 wherein said temperature sensor measures outdoor temperature and said at least one remote sensor further includes:

means for measuring the occurrence of rain in excess of a predetermined amount; and

means for measuring the occurrence of wind in excess of a predetermined amount.

12. A control system as defined in claim 11 wherein:

said transmitting means additionally transmits an indication of said measured wind and said measured rain to said programmed controller in response to said interrogations.

13. A control system as defined in claim 10 wherein said at least one sensor measures indoor temperature and said at least one remote sensor further includes:

means for measuring the indoor light level of said greenhouse.

14. A control system as defined in claim 13 wherein:

said transmitting means additionally transmits an indication of said measured light level to said programmed controller in response to said interrogations.

15. A control system as defined in claim 5 wherein said address controller includes:

means for receiving commands from said programmed controller as to the state of at least one actuator;

means for distributing actuation signals based on said received commands; and

means, controlled by said actuation signals, for controlling a plurality of actuators to determine the operational state of said remotely controlled elements.

16. A control system as defined in claim 15 wherein:

one of said remotely controlled elements is a ventilation fan.

17. A control system as defined in claim 15 wherein:

one of said remotely controlled elements is a fuel valve of a heater element.

18. A control system as defined in claim 15 wherein:

one of said remotely controlled elements is a fan motor of a heater element.

19. A control system as defined in claim 15 wherein:

one of said remotely controlled elements is a pump supplying water to a cooling pad.

20. A control system as defined in claim 5 wherein said address controller includes:

means for receiving commands from said programmed controller indicative of the position of one of said controlled elements; and

means for converting said commands into a proportional signal which positions said controlled element to the commanded position.

21. The control system as in claim 1 further including means for communicating on sidebands about a center frequency over said AC power line, comprising:

transmitter means for converging a digital binary signal having two binary levels into an upper sideband signal in response to one of said binary levels, and a lower sideband signal in response to the other binary level,

means for coupling said sideband signals to said AC power line; and

receiver means, coupled to receive said sideband signals from said AC power line, for converting said upper and lower sideband signals to respective binary logic level digital output signals.

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L1: Entry 13 of 13

File: USPT

Apr 15, 1986

DOCUMENT-IDENTIFIER: US 4583090 A

TITLE: Data communication system

Brief Summary Text (3):

In general, the direct control of electrical loads has been practiced for many decades using various technologies. Since the inception of a significant public awareness in the limitations of energy as a resource and because of significant cost increases, considerable effort has been made to develop direct, utility-operated load management operational systems. The principal proposed use requires a communication channel from the utility to the consumer's location. This has required an effective means for transmitting a data signal over the channel as well as a simple and reliable receiver capable of decoding the signal and employing the result to control load function, e.g., for turning loads on and off. Even this relatively simple objective is difficult to achieve.

Brief Summary Text (29):

Another object of the invention is to provide for a transmitter control unit (TCU) for use in a communications system of the above character in which a computer may be dedicated for use at the transmitter and in which the TCU operation does not require a computer for its operation.

Brief Summary Text (32):

Another object of the invention is to provide a load control system of the above character.

Brief Summary Text (33):

Another object of the invention is to provide a load control system of the above character employing a receiver including a fail safe relay driver circuit which requires a continuously energized output from the control circuits or automatically shifts into a fail safe "ON" mode.

Brief Summary Text (36):

The present invention utilizes a baseline system which is incorporated and transmitted on a commercial FM SCA broadcast frequency and is received and decoded by a specially designed receiver to provide individually addressable communication links between the utility control center and all loads so equipped in the utility service territory. Selective consumer addressing is provided so that the loads may be individually addressed or addressed in units of such small numbers as to provide any desired selective communication. The structure and length of the message format is variable and selected by the control computer to provide sufficient length and complexity desired to accomplish the control protocol but the sufficiently short messages to be made in truncated form so that very rapid transmission rates can be obtained. This is accomplished using a special terminate symbol which at any point in the address portion of the message to truncate it. Thus, a unique address for the selected loads can be provided as for example to select by zone, sub-station, customer type, and geographical area the loads to be effected. By use of the terminate symbol, however, it is not necessary to transmit this full address in most messages. Another special symbol, a "DON'T CARE" or "WILDCARD" symbol, can be

used within the transmitted portion of the address to obtain "Logical Group Addressing," such as to simultaneously address all loads of a specific customer type, regardless of their zone, sub-station, geographical area, etc.

Detailed Description Text (2):

A block diagram of the total system is shown in FIG. 4 as particularly adapted for QPSK operation and a diagram of the overall system adapted for TCSK transmission is shown in FIG. 6. There are three principle sub-systems: the master control station at the utility control center, the studio transmit or sub-system at the broadcast station studio or transmitter, and the remote load control unit or receiver.

Detailed Description Text (3):

The control station may employ a conventional computer such as a Digital Equipment Corporation (DEC) PDP11/23 mini computer which is programmed according to the procedures set forth in the present invention and is linked to the FM transmitter sub-system at the broadcast channel through a suitable communication line such as a leased telephone circuit or microwave channel.

Detailed Description Text (31):

Command Terminator (1 bit minimum, possibly 2 bits to allow adequate time for command decoding to determine if post--command bits are to be received and what to do with them e.g., security bit check, write to display, etc.)

Detailed Description Text (32):

Post-Command Data [If Required for Specific Command Message] (Variable length, up to 256 bits, as determined by the nature of the command for security check bit requirements, for example, as by length specification by the data word for "data transfer" instructions, as to a display device)

Detailed Description Text (63):

Referring generally to FIG. 6, there is shown a generalized communication system, in three stages, utilizing TCSK techniques in accordance with the present invention. The first stage is located at the utility and consists of a master control computer 55 having a binary output which is fed into a ternary frequency shift key (FSK) generator 11, whose output is a tri-tone FSK signal which can be transmitted via telephones 12 and 13 over telephone lines to the next stage. The first stage is shown in greater detail in FIGS. 7 and 8. The second stage, which is shown in greater detail in FIG. 9, is located at an FM broadcast transmitting facility. By transmitting facility, it is meant either a combined studio and transmitter or, if divided, a studio and transmitter which are interconnected by some communications link not shown and not necessary to the understanding of this invention. A tri-tone FSK to TCSK converter 14 at the studio receives the utility computer information in tri-tone and converts it to TCSK in a manner described below. The TCSK signal is that portion so marked in the lower frequency domain of FIG. 2. This TCSK signal is applied to the exciter 15, and then transmitted by the standard FM broadcast signal transmitter 16 over RF link 17 as a sub-audio transmission added to the SCA channel. The third stage includes a TCSK receiver 18 located at the user's load facility which is capable of decoding the SCA channel and separately decoding the TCSK signal to produce a ternary signal as previously described. This signal is converted to binary and operates a microprocessor in receiver 18 which is pre-programmed to carry out the various functions of this invention when so enabled. Generally speaking, the output of the receiver 18 can terminate in any type of load control device, a fail safe relay system 19 being shown which is located between the circuit breakers 20 at the user's location and the load 21 itself. The fail safe delay 19 operates to disconnect the load 21 from the power lines when so commanded.

Detailed Description Text (93):

With the current protocol design, the address field has a maximum length of nine symbols. The nine symbols have tentatively been identified as the user type,

subgroup, substation, and unique ID, but these designations are totally meaningless to the LCR software. The LCR simply contains a string of TCSK symbols which must be compared to the received symbols according to a few simple rules. The LCR's ID consists of strictly hexadecimal symbols (0-F) and may not contain the symbols X, T, or S. If a hexadecimal symbol is received, the received symbol is compared with the LCR's corresponding ID symbol. If the symbols do not match, the message reception is aborted. If the received symbol is an X (don't care), the received symbol is assumed to match any LCR ID symbol. If the message transmitter wishes to send fewer than nine address symbols, the last symbol must be the T (terminator) symbol. FIG. 19 contains the flowchart for the address recognition routine.

#### Detailed Description Text (101):

Contained within the 8035 microcomputer 190 in FIG. 10 is an 8-bit timer that ticks at a 12.5 KHz rate, or once every 80 usec. It is this timer that determines when to sample an incoming message. Because this timer is very stable and accurate (controlled by the system's 6 MHz crystal), the timer is used as the basis for the LCR's time of day clock. Because the basic TCSK chip time is 10 msec, the timer is forced to expire once every 10 msec. By counting 100 chip intervals the microcomputer can determine when one second has expired. One minute is obviously recognized after counting 60 seconds. One day consists of counting 1440 minutes. Thus, by using the 8035's internal timer the LCR can determine the time of day with a precision of one minute.

#### CLAIMS:

2. The load management control system in claim 1 in which said TCSK code includes a symbol the transmission of which indicates a truncate command, and wherein each of said plurality of receivers includes means responsive to said truncate command to shorten transmission and reception times.

3. The load management control system in claim 1 in which each said load controlling means comprises a microprocessor to generate load control signals.

5. An electrical power control transmission system for communicating data, said transmission system comprising:

a transmitter for transmitting said data, said transmitter including a ternary character shift keying (TCSK) generator for encoding said data as a series of ternary bits and for transmitting a different frequency for each state of said ternary bits; and

a receiver coupled to said transmitter over a communication channel for receiving said transmitted data, said receiver including

an electrical load,

power relays for controlling said electrical load,

means for decoding said transmitted data into baseband data stream for operating said power relays to switch said electrical load, and

a fail safe circuit coupled to said relays and said decoding means to prevent improper operation of said system in case of system failures.

6. The communication system in claim 5 wherein said receiver includes a microprocessor, and said fail safe circuit includes a charge pump capacitor input into which the microprocessor continuously supplies a series of pulses to maintain said fail safe circuit in a microprocessor-controlled state.

7. A system for communicating data comprising

a transmitter for transmitting said data, said transmitter including a ternary character shift keying (TCSK) generator for encoding said data as a series of ternary bits and for transmitting a different frequency for each different state of said ternary bits; and

a receiver coupled to said transmitter over a communication channel for receiving said transmitted data, said receiver including

a digital decoder for decoding said transmitted data and recovering a baseband data stream,

zero crossing generator means for developing a series of first pulses each corresponding to a different rising and falling edge of said baseband data stream,

pulse generator means responsive to said first pulses for generating a series of second pulses having uniform characteristics, each of said second pulses corresponding to a different one of said first pulses, and

means for generating a signal representing the average strength of said first pulses.

10. A system for communicating data comprising:

a transmitter for transmitting said data, said transmitter including

a ternary character shift keying (TCSK) generator for encoding said data as a series of ternary bits and for transmitting a different frequency for each different state of said ternary bits, and

first means for filtering said data stream to reduce the energy outside a predetermined frequency range necessary for transmission of said ternary bits; and

a receiver coupled to said transmitter over a communication channel for receiving said transmitted data, said receiver including

second means for filtering out noise and co-channel interference from said communication channel, and

means for decoding said transmitted data into a baseband data stream,

said first and second filtering means being constructed and arranged to form a cascade pair for wave shape control of said transmitted data.

15. A system for communicating electrical load control data comprising:

a transmitter for transmitting said data, said transmitter including a ternary character shift keying (TCSK) generator for encoding said data as a series of ternary bits and for transmitting a radio wave signal at a different frequency corresponding to each different state of said ternary bits; and

a plurality of receivers each coupled to said transmitter over a different communication channel for receiving said transmitter data, each said receiver including

an electrical load,

means for controlling said electrical load,

means for receiving and decoding said transmitted data into a baseband data stream

in binary format, and

microprocessor means coupled to said receiving and decoding means for receiving said baseband data in binary format and for developing a preamble to obtain a synchronization signal, an address identifier to provide a user enable function, and a data recognition command signal, thereby to direct said load controlling means to control said electrical load.

17. A system for communicating data comprising:

a transmitter for transmitting said data, said transmitter including a ternary character shift keying (TCSK) generator for encoding said data as a series of data chips, each said chip comprising four ternary bits, and for transmitting a different frequency for each different state of said ternary bits, one of said frequencies being a center frequency and the other frequencies being offset from said center frequency by an equal amount, said TCSK generator forming said data chips such that the net frequency of the transmitted ternary bits for each said data chip equals said center frequency; and

a receiver coupled to said transmitter over a communication channel for receiving said transmitted data, said receiver including means for decoding said transmitted chips into a baseband data stream.

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L1: Entry 1 of 13

File: USPT

May 14, 2002

DOCUMENT-IDENTIFIER: US 6388399 B1

TITLE: Network based electrical control system with distributed sensing and controlAbstract Text (1):

An electrical control system including a plurality of electrical devices communicates over a network and interfaces and works with non-protocol devices and signals that only send/receive an on/off digital signal or send/receive one of numerous analog signals. The devices communicate with one another over a network implemented using different types of media. The system includes the necessary user interfaces, network management system interfaces and displays to provision, administer, operate and maintain the electrical device network. The system is particularly suited for lighting control applications to control the lights and/or other electrical loads within an office, building, room or home by motion detection, ambient light sensing, switching functions, dimming functions, temperature sensing functions and humidity sensing functions. Most devices are equipped to put the device in an ON, OFF, or AUTO mode.

Brief Summary Text (2):

The present invention relates generally to the field of control systems and more particularly to a lighting control system for controlling the operation of electrical lighting devices.

Brief Summary Text (7):

Thus, it is desirable to create an open control system whereby individual components and subsystems share information among one another. A few of the benefits of using an open system include reduced energy costs, increased number of design options for the facility manager, lower design and installation costs since the need for customized hardware and software is greatly reduced and since star configuration point to point wiring is replaced by shared media and lastly, system startup is quicker and simpler.

Brief Summary Text (12):

The present invention comprises an electrical control system that includes various electrical devices that have the capability to communicate over a network. The various electrical devices include sensors, transducer functions, switching devices, dimming devices and controlling devices. The devices communicate with one another over a network that may be implemented using one or more different types of media. Media types include, for example, twisted pair, power line carrier, coaxial, optical fiber, RF and infrared. Some of the devices may or may not include an integral power supply. Thus, some devices may depend on other devices to supply them with electrical power.

Brief Summary Text (13):

In addition, the system includes the necessary user interfaces, network management system interfaces and displays to provision, administer, commission, operate and maintain the electrical device network. The system is particularly suited for lighting control and load switching/dimming applications, including but not limited to, providing a means to control the lights and/or other electrical loads within an office, building, room or home by means of motion detection, ambient light sensing, switching functions, dimming functions, temperature sensing functions and humidity

sensing functions. Most devices are equipped with a means to put the device in an on, off or auto mode.

Brief Summary Text (15):

The electrical devices that comprise the control system generally comprises one or more of the following five basic elements: (1) user interface, (2) actuator element, (3) power supply and media connections, (4) communications media and protocol and (5) one or more sensor inputs.

Brief Summary Text (16):

For the control system to function it is not necessary for all five of the above elements be present. A device may operate if connected to elements in other devices which are not part of the system, such as a separate micro PLC type device connected directly to a relay or other switching element which, in turn, is connected to one or more of the sensors within the system. Further, it is intended that many other sensors, other than those disclosed herein, could also work directly with the system of the present invention. Typically, little or no modification is required and the required functional profiles and variables or other application code can be downloaded to the appropriate user interface, actuator element, power supply or sensor inputs.

Brief Summary Text (17):

Additionally, other functions can be performed which include some type of annunciation either by sound (by using a buzzer), by sight (by employing LEDs) or by controlling the lights in the room. For example, if there is a fire and the smoke detector transducer and sensor indicates the fire, a local buzzer could annunciate at the sensor and also cause the lighting control unit to flash lights. Alternatively, it could illuminate specially designed lights fixtures made for this purpose. Also, the lighting system could be controlled through inputs received from a security system which outputs commands so as to put the home or office into a 'lived in look' mode or other appropriate lighting modes.

Brief Summary Text (18):

The user interface, utilized by a user to configure and maintain the devices situated on the network, is optionally present in the network. The user interface can be a hand held device, laptop, palmtop, desktop or a remote control device. In addition, the user interface can be located locally or remotely and may comprise a computer, a touch screen panel or display, a simple keypad or any other wall, surface, tabletop, cellular or other type device that allows any user to interface with the system to either receive information, to control elements of the system, to perform network management on the system and its devices or to report automatically or upon command.

Brief Summary Text (22):

Another key feature of the system is a communications media and protocol that together form a communications network allowing messages to be communicated (1) between devices within the system and (2) between devices located within the system and devices located external to the system. The messages comprise, among other things, commands for controlling and/or monitoring signals and data. These messages could be tightly coupled, loosely coupled or of a macro broadcast nature. In addition, they may be one way, bi-directional, with established priorities or without. The network communications medium may comprise, for example, twisted pair Category 5 cabling, coaxial cabling, a standard POTS line, power line carrier, optical fiber, RF or infrared. The medium may be common or it may be shared with the possibility of requiring the use of gateways, routing devices or any other appropriate network device for carrying control commands and data signals.

Brief Summary Text (23):

Depending on the type of network medium in use in the system, the devices within the system include, within their housings, a slot that allows for the connection of

a bus terminator. The bus terminator is typically an RC network that is connected to the device and serves to mechanically, as well as electrically, connect the device to the network communication line, e.g., twisted pair, coaxial, optical fiber, etc.

Brief Summary Text (26):

The utility of the system of the present invention, including the individual devices that comprise it, can be illustrated using an example. Consider, for example, that in order to improve the chances of interoperability amongst different products which are developed and sold by different organizations, it is desirable to have a system which can reliably provide lighting control without restricting the building owner to devices or systems from one manufacturer. This is especially so if the system does not allow for the addition of other types of sensors that are needed to control the lighting or HVAC within an office complex. Thus, the system is very useful as it not only will function with devices that were originally designed to work within the system, but will also operate with devices developed by other organizations which utilize the same communications protocol. Note that the choice of communications protocol and physical layer for the medium is not material to the invention. Any suitable physical, link and network layer may be used to implement the system of the present invention including, but not limited to the communication layers specified in the LonWorks protocol (Echelon), CEBus (Intellon), X10, CAN, BACNet, etc.

Brief Summary Text (27):

The system offers an installer a control unit, which may be a single device that comprises (1) a power supply to provide electrical power to other sensors and peripherals, (2) a system reset function, (3) load switching or dimming elements, (4) the ability to accept additional functionality permitting program instructions to be downloaded to internal nonvolatile memory, e.g., flash memory, over the network, (5) the ability to send operating mode scheduling commands, and (6) multiple processing means for implementing networking firmware in addition to application firmware previously downloaded or stored in ROM.

Brief Summary Text (28):

Moreover, given that devices generally have the ability to accept changes to their firmware via the network, it is preferable that the control units comprise a microprocessor or microcontroller which functions to execute the networking functions and the application or functionality of the system and the control unit itself. It is also preferable that the control unit is connected, via the network or directly, to a variety of sensors that are used to control various loads such as lighting and HVAC system loads. In addition, the control unit may be adapted to (1) help implement a security system inside or outside of a room or building, (2) sense sensor signals and send an alarm to a fire alarm or (3) automatically turn lights on during a fire, if so desired.

Brief Summary Text (29):

It is important to note that the invention is not limited to providing distributed sensing and control using a communication protocol such as Echelon's LonWorks or BACNet over a twisted pair hard wired media or RF link. The invention also provides the flexibility to incorporate additional devices into the system regardless of whether one organization or many manufacture them. As long as the devices are manufactured to conform to the communication specification/protocol in use, the devices can communicate and interoperate with each other over the network.

Brief Summary Text (30):

For example, a control unit device may contain a temperature sensor to detect hot spots on the device and, in response, automatically adjust the power, switching output or dimming output capability in accordance with the temperature measured in real time within the device. Thus, the total load carrying capability of the system can be switched or dimmed based upon the current ambient temperature in a plenum or

riser or system power supply, for example. Other components of such a control device include application code and device control firmware, a load switching or dimming element, low voltage inputs/outputs including: 0 to 24 mA, 100 ohm to 20 Kohm resistive and 0 to 10 V analog inputs, 0 to 30 VDC and dry contact digital inputs, 0 to 12 VDC 100 mA source and sink digital outputs, other non-protocol inputs/outputs, 0 to 10 V ballast I/O, twisted pair to PLC routing, add-on modules to provide additional dimming capability, energy monitoring device and means to optionally receive power from a source of AC power.

Brief Summary Text (39):

An example of an application, specifically the food services and restaurant industry, is to provide audio, video, lighting control and the ability to place an order right at the customer's table in a restaurant. That is, via a user interface, e.g., display, touch screen, a customer at a restaurant can select and adjust different types of entertainment such as music, TV channels, movies, etc right at her/his table. Further, they could also set the lighting level to any desired level including different dim levels, scenes, patterns, etc. Through this interface, the customer could place their order, set their lighting level, select their entertainment, set the temperature and basically have full control over their comfort.

Drawing Description Text (5):

FIG. 3 is a block diagram of a control unit constructed in accordance with the present invention;

Drawing Description Text (6):

FIG. 4 is a schematic diagram illustrating the relay driver circuit portion of the control unit in more detail;

Drawing Description Text (7):

FIG. 5 is a schematic diagram illustrating the ballast dimming circuitry portion of the control unit in more detail;

Drawing Description Text (8):

FIG. 6 is a schematic diagram illustrating the dimming circuitry portion of the control unit in more detail;

Drawing Description Text (9):

FIG. 7 is a schematic diagram illustrating a zero detect circuitry portion of the control unit in more detail;

Drawing Description Text (10):

FIG. 8 is a block diagram illustrating the communications transceiver portion of the control unit in more detail;

Drawing Description Text (11):

FIG. 9 is a block diagram illustrating the software portion of the control unit;

Drawing Description Text (12):

FIG. 10 is a block diagram illustrating an example network utilizing a plurality of occupancy sensors and a control unit coupled to a load;

Drawing Description Text (13):

FIG. 11 as a block diagram illustrating an example network utilizing a plurality of dimming sensors and a control unit coupled to a dimming load;

Drawing Description Text (14):

FIG. 12 is a block diagram illustrating an example network utilizing a plurality of sensors and a control unit coupled to a load wherein an inhibit signal is communicated to the control unit which supplies a feedback signal to the plurality

of sensors;

Drawing Description Text (15):

FIG. 13A is a state diagram illustrating the state transitions for a control unit connected to a load and coupled to an occupancy sensor and a switch;

Drawing Description Text (18):

FIG. 15 is a schematic diagram illustrating the LED display circuitry of the dimmer switch unit in more detail;

Drawing Description Text (19):

FIG. 16 is a block diagram illustrating the software portion of the dimmer control unit in more detail;

Drawing Description Text (20):

FIG. 17 is a diagram illustrating a dimmer/switch sensor unit suitable for use with the control system of the present invention;

Detailed Description Text (5):

The present invention is a local operating network or network based control system suitable for multiple devices having different functionality. As an example, the local operating network can be applied to lighting, HVAC, monitoring and alarm systems. The local operating network, i.e., the system, comprises among one or more devices, a user interface, actuator element, power supply, communications media, media connections and protocol and sensor inputs. These components function to work together with other devices that can communicate using the same standard communication protocol to form a local operating network. The system comprises various device functionality including but not limited to various sensor and transducer functions such as motion detector sensors, temperature sensors, humidity sensors, light sensors and dimming sensors. The devices may be packaged in various form factors including but not limited to surface mount, flush mount, plug-in, hardwired, wall mount and single or dual gang wall box and ceiling mount. Other features include light harvesting or constant light maintenance, lumen maintenance, time of day scheduling, on/off/auto switching and sensing, single and multiple 20 A 100 to 305 VAC switching devices for incandescent, fluorescent lighting and motor loads and 8 A 800 W 100 to 305 VAC dimming triac devices with a series air gap relay element. The devices comprise software and/or firmware for controlling the operation and features of the device, 15 VDC power supply for supplying external devices with power, a reset push button for resetting the device and a communications network media interface.

Detailed Description Text (6):

To aid in understanding the principles of the present invention, the control system is described in the context of the LonWorks communication protocol developed by Echelon and which now is a standard EIA 709.1 Control network Protocol Specification, incorporated herein by reference. Other related specifications include EIA 709.2 Control Network Powerline Channel Specification and EIA 709.3 Free Topology Twisted Pair Channel Specification, both of which are incorporated wherein by reference.

Detailed Description Text (7):

The scope of the present invention, however, is not limited to the use of the LonWorks protocol. Other communication network protocols such as CEBus, etc. can be used to implement a control network within the scope of the present invention. In addition, non-protocol inputs can be tied in such as switch and various other low voltage contact closures or outputs or analog signal inputs and outputs.

Detailed Description Text (8):

A block diagram illustrating an example control system network consisting of various electrical controls, devices and sensors is shown in FIG. 2. The control

network, generally referenced 30, comprises an example control system that has applications in lighting, HVAC systems, fire and security. The network 31 may comprise any type of media suitable with the network implemented. For the case of LonWorks, the media can be chosen from twisted pair, power line carrier, optical fiber, RF and coaxial. Different media can be used to construct a single network by the use of bridges, gateways or routers linking one type of media to another.

Detailed Description Text (9):

The network 30 comprises a lighting portion consisting of a control unit 36 with a plurality of attached electrical loads #1 through #N 38, occupancy sensor 32, dimmer 34, ambient light sensor 44 and switch 42. The network also comprises a temperature sensor 46 measures the local temperature, access control system 48 for controlling access to particular areas, HVAC system 50, energy management system 52, fire alarm system 54 and security system 40. A gateway 56 functions to bridge the local network 31 to external networks, which may or may not be LonWorks networks.

Detailed Description Text (12):

For a device to be interoperable it must communicate in accordance with the protocol specification in use in the system, e.g., LonWorks, CEBus, etc. If a device complies with the standard or protocol in use, it can communicate with other devices in the system. For example, the switch, in response to a user's command, can cause the control unit to turn on one of the connected loads. The temperature sensor may be bound (as defined by the LonWorks protocol) to the HVAC system, for example. After a threshold temperature is exceeded, the temperature sensor can respond by sending a command to the HVAC system to turn on the air conditioning.

Detailed Description Text (13):

In this system, all the subsystems, i.e., HVAC, security, fire alarm, etc. share information. Thus, building wide tasks can be performed from a single location through embedded software. This helps reduce operating costs and permits expansion, modifications and integration of new systems without disrupting the ongoing operation of the building. Also, devices that do not have a protocol can be tied into this system and thus can controlled and can share information, perhaps to a lesser degree. This permits simple low cost non-protocol devices to be tied into a network thus offering an optimized system solution.

Detailed Description Text (14):

Control Unit

Detailed Description Text (15):

A block diagram of a control unit constructed in accordance with the present invention is shown in FIG. 3. The control unit, generally referenced 60, can be adapted for various applications, one of which being lighting controls which is the example presented hereinbelow. The control unit shown in this example is adapted to control motors, fluorescent and incandescent lighting loads. Control units adapted to function in other applications can also be constructed and is contemplated to be within the scope of this invention.

Detailed Description Text (16):

Various loads can be connected to the unit including one or more fluorescent ballasts 82, one or more relay loads 84, one or more dimming loads 86 and motor loads. The control unit 60 comprises a controller 90 to which are connected various components, reset/power supply monitor circuitry 62, clock circuitry 64, zero detect circuit 66, power supply 70, communications transceiver 92. Also included are ballast dimming circuitry 98, relay driver circuit 100 and dimming circuitry 102.

Detailed Description Text (19):

A momentary contact switch 68 is provided which functions to momentarily disconnect

the external power supply, thus providing a reset function for devices that receive power from the control unit 60.

Detailed Description Text (21):

In the case of LonWorks compatible networks, the control unit 60 comprises a service pin to which is connected a momentary push button switch 76 and service indicator 74. The switch 76 is connected between ground and the cathode of the LED 74. The anode of the LED is connected to V.sub.cc via resistor 72. A zener diode 78 clamps the voltage on the service pin to a predetermined level. The switch 76 is connected to the service pin via a series resistor 80. The service pin on the controller functions as both an input and an output. The controller 90 is adapted to detect the closure of the switch 76 and to perform service handling in response thereto. A more detailed description of the service pin and its associated internal processing can be found in the Motorola Databook referenced above.

Detailed Description Text (22):

The control unit 60 interoperates with other devices on the network. The communication means comprises a communication transceiver 92 that interfaces the controller 90 to the network. The communications transceiver 92 may comprise any suitable communication/network interface means. The choice of network, e.g., LonWorks, CEBus, etc. in addition to the choice of media, determines the requirements for the communications transceiver 92. Using the LonWorks network as an example, the communications transceiver may comprise the FTT-10A twisted pair transceiver manufactured by Echelon Corp, Palo Alto, Calif. This transceiver comprises the necessary components to interface the controller to a twisted pair network. Transmit data from the controller 90 is input to the transceiver which functions to encode and process the data for placement onto the twisted pair cable. In addition, data received from the twisted pair wiring is processed and decoded and output to the controller 90. Transceivers for other types of media such as power line carrier and coaxial, for example, can also be used.

Detailed Description Text (23):

As described above, the control unit also comprises means for controlling various lighting loads. In the example shown here, three different types of loads can be controlled: (1) ballasts for fluorescent lights, (2) any electrical device that can be controlled via a relay and (3) a dimming load. The ballast dimming circuitry 98, via a BALLAST signal from the controller 90 controls fluorescent ballasts. Relay loads are controlled by the relay driver circuit 100, via a RELAY signal from the controller 90. Dimming loads are controlled by the dimming circuitry 102 via DIMMING and DIM RELAY signals output from the controller 90. Motor loads are controlled by the motor controller 103. Low voltage analog devices are controlled via analog 0-10 V circuitry 105.

Detailed Description Text (24):

In addition, external devices that do not implement a protocol can be tied into the network via the Non-Protocol I/O connection to the controller 90. Thus, non-protocol I/O devices can be controlled and can share information with other protocol enabled devices. This enables low cost non-protocol devices to be tied into the network thus providing an optimized system solution.

Detailed Description Text (25):

A schematic diagram illustrating the relay driver circuit portion of the control unit in more detail is shown in FIG. 4. The relay driver circuit 100 comprises a transistor circuit for controlling the coil 118 of a relay 120. The RELAY signal from the controller is input to the base of transistor 114 via resistor 112 and resistor 110 connected to ground. The coil 118 is placed in parallel with a diode 116 and connected between the 15 V supply and the collector of transistor 114. The diode 116 functions to suppress the back EMF generated by the coil when it is de-energized. In accordance with the RELAY signal, the circuit functions to open and close the relay 120 that is connected to the relay load.

Detailed Description Text (26):

A schematic diagram illustrating the ballast dimming circuitry portion of the control unit in more detail is shown in FIG. 5. The ballast dimming circuit 98 comprises an op amp 134 and associated components which functions to output a signal in the range of 0 to 10 VDC. The output signal causes fluorescent lights that are equipped with electronic ballasts to dim to a particular level. The electronic ballasts are adapted to receive a standard 0 to 10 V signal that corresponds to the desired light intensity level. The electronic ballast consequently adjusts the voltages applied to the bulbs they are connected to in accordance with the level of the input ballast-dimming signal. Additionally, the control unit can offer a 0 to 10 V output, via analog 0-10 V circuitry 105 (FIG. 3), whereby either 0 or 10 V correlates to the ON or maximum controlled state and the other voltage extreme, i.e., 10 V or 0 V respectively, correlates to the OFF or minimum controlled state. The voltages in between correlate linearly with load performance or by any other suitable fashion.

Detailed Description Text (28):

A zener diode 140 prevents the ballast output signal from exceeding a predetermined value. Note that the control unit may comprise a plurality of ballast dimming circuits for dimming a plurality of fluorescent light loads.

Detailed Description Text (29):

A schematic diagram illustrating the dimming circuitry portion of the control unit in more detail is shown in FIG. 6. The dimming circuitry 102 functions to control the light level of an incandescent load (a dimming load). The dimming circuit 102 comprises two portions: a triac dimming portion and a relay portion. The triac dimming portion comprises a triac 160 that is turned on at different points or angles of the AC cycle to effect the dimming function. The triac 160 is triggered by an opto coupled diac 152 which comprises an LED 154 optically coupled to a diac 156. The diac 156 is connected to the gate of the triac 160. The DIMMING signal from the controller turns on the LED 154 whose anode is connected to Vcc via resistor 150. The DIMMING signal is brought low when the triac is to be turned on. The timing of the signal input to the opto coupled diac is synchronized with the zero crossings of the AC power. While the dim level of the load is set to non zero, the DIMMING signal is applied on a periodic basis, i.e., every AC half cycle.

Detailed Description Text (31):

A schematic diagram illustrating the zero detect circuitry portion of the control unit in more detail is shown in FIG. 7. The zero detect circuit 66 functions to generate a ZERO\_DETECT signal every half cycle of the phase and neutral lines that is monitored by the controller 90. The phase and neutral lines from the AC power are input across a full wave bridge rectifier comprising diodes 190, 192, 194, 196. The voltage across the output of the bridge rectifier is placed across a voltage divider comprised of resistors 200, 198. A zener diode 202 is connected to the junction of the voltage divider. At the beginning of the AC cycle, the zener is off, and a voltage appears at the gate of FET 206, turning it on. A current path is created from the output of the bridge, through the LED 210, FET 206 and resistor 208. The LED 210 in the opto coupler 214 is turned on. In response, the output of the opto coupler, which is pulled to Vcc by resistor 218 is brought low. Once the FET is turned on it conducts current, a voltage is developed across resistor 208 which causes transistor 204 to turn on, clamping the gate of FET 206 to ground, turning FET 206 off. Thus, at each zero crossing of the AC voltage, a short pulse is generated which the controller can read. The zener diode 202 prevents the voltage across the gate of FET 206 from exceeding a predetermined voltage.

Detailed Description Text (32):

A block diagram illustrating the communications transceiver portion of the control unit in more detail is shown in FIG. 8. As described previously, the communications transceiver 92 functions to enable the control unit to communicate with other

devices over the network. Each device in the network incorporates communications means enabling it to share information with other devices. In this example, the communications transceiver 92 is adapted to transmit and receive data over twisted pair wiring. As mentioned previously, the communication transceiver could be adapted to other type of media as well including, but not limited to, power line carrier, coaxial, RF, etc.

Detailed Description Text (36):

A block diagram illustrating the software portion of the control unit is shown in FIG. 9. The hardware and software components of the control unit in combination implement the functionality of the device. The software portion of the control unit will now be described in more detail. Note that the implementation of the software may be different depending on the type of controller used to construct the control unit. The functional tasks presented herein, however, can be implemented regardless of the actual controller and/or software methodology used. In the example presented herein, the controller is a Motorola Neuron 3120, 3150 or equivalent. Some of the functionality required to implement the control unit is incorporated into the device by the manufacturer. For example, the processing and associated firmware for implementing the physical, link and network layers of the communication stack are performed by means built into the Neuron processor. Thus, non-Neuron implementations of the control unit would require similar communication means to be able to share information with other devices over the network.

Detailed Description Text (38):

The various tasks described herein together implement the functionality of the control unit. Each of the tasks will now be described in more detail. The main control task 240 coordinates the operation of the control unit. The control task is responsible for the overall functioning of the control unit including initialization, housekeeping tasks, polling tasks, etc. In general, the control unit is adapted to respond to commands received over the network from external sensor and control devices. The control is effected by the use of network variables referred to as Standard Network Variable Types (SNVTs), in the case of LonWorks networks, for example. Thus, based on the values of the various network variables received by the control unit, the control unit responds and behaves accordingly. The following described the functionality provided by the control unit.

Detailed Description Text (40):

The relay task 242 functions to control the on and off state of the one or more relays in the control unit. Each relay has an associated relay driver circuit 100 (FIG. 3) and a relay load. Using network variables within the context of a LonWorks based network, the relay task may respond, i.e., be bound, to various network variables. The relay task may be suitably programmed to respond to settings of an ON/AUTO/OFF switch on a switch or dimming device. If the switching input value is set to on, then the relay is turned on regardless of the setting of a bound occupancy sensor device or other sensor device. Thus, if a user turns the switch to the ON position, the relay task would respond by turning the relay on provided that the control unit is not in the inhibited state (described in more detail hereinbelow). The relay would stay on, regardless of the state of other bound sensor devices such as occupancy sensor devices. The relay task also responds to the on/off commands from a bound switch device, turning the relay on and off accordingly. When in the AUTO state, the relay load is controlled by the sensors bound to it over the network.

Detailed Description Text (42):

The occupancy task 256 functions to control a relay or dimming load in accordance with the detection of motion in an area. One or more occupancy sensor devices can be bound to a relay or dimming object within the controller. A block diagram illustrating an example network utilizing a plurality of occupancy sensors and a control unit coupled to a load is shown in FIG. 10. Occupancy sensors 270 labeled #1 through #N are shown bound (OCCUPANCY 276) via the network to the control unit

272. The load 274 to be switched or dimmed is coupled to the control unit 272. In a LonWorks network, any number of sensors can be bound to the same object (load). Note that the occupancy task does utilize any feedback from the control unit. In addition, more than one load can be connected to and controlled by the control unit.

Detailed Description Text (43):

In addition, a light harvesting feature (described in more detail below) can be enabled or disabled for each input. This feature utilizes the light level sensed by an ambient light level sensor also connected to the network. When occupancy is detected, the sensor functions to generate a command that is sent to the occupancy task in the control unit. The command is sent via the setting of a value for a particular network variable. The occupancy task first checks the current level of the light. If light harvesting is enabled, the lights turn on in accordance with the light harvesting task (described in more detail below). The ambient light level is periodically checked and the brightness of the lights are adjusted accordingly. If light harvesting is not enabled, then the lights are turned on in accordance with the following Lighting Priority Order:

Detailed Description Text (49):

In addition to light harvesting, the control unit can incorporate a lumens maintenance task 245 which functions to drive the dimming output to less than the maximum value. This results in driving the lighting load to less than its full wattage rating thus saving energy. As time progresses, the control unit can then drive the lighting load harder to maintain the light level at a constant lumens level. As a lamp ages its light output naturally decreases, all else being equal. Therefore, if the lighting output of the control unit initially drives the lamp at 90% of its maximum rating, then over time it can automatically, or through a scheduler input or through the use of an ambient light sensor, drive the lighting load at 91%, then 92% etc. Thus, providing lumens maintenance in addition to saving energy.

Detailed Description Text (52):

A block diagram illustrating an example network utilizing a plurality of dimming sensors and a control unit coupled to a dimming load is shown in FIG. 11. A plurality of dimming sensors 280 labeled #1 through #N are bound (DIMMING CONTROL 288) to the control unit 282 via the network. The dimming load 284 is connected to the control unit 282. Note that the control unit may be adapted to control virtually any number of dimming loads in similar fashion to that described here. In addition, a feedback signal (FEEDBACK 286) is bound from the control unit to each of the dimming sensors 280.

Detailed Description Text (53):

On each of the dimming sensors, the brightness level is adjusted by pressing a switch. Pressing up on the switch increases the brightness level by an incremental amount, e.g., 1/2 or 1 full unit of resolution. When the switch is pressed up, a command is sent from the dimming sensor to the control unit that is bound to that dimming sensor. To dim the light, the switch is pressed in the down direction. The dimming sensor is described in more detail below.

Detailed Description Text (55):

If more than one dimming sensor is bound to the same dimming load in the control unit, then feedback is used to communicate information from the control unit to each of the dimming sensors bound to it. Feedback is utilized to inform the other sensors that are also controlling the dimming load as to the state of the dimming load. Thus, all the dimming sensors are synchronized and via feedback from the control unit are able to effectively track the actions of each other. The control unit preferably sends the feedback information after each command is received. For example feedback may be sent to all the bound dimming sensors 200 ms after the last command related to the light level is received.

Detailed Description Text (64):

The light harvesting task 264 can be enabled or disabled by the user. This task typically operates in conjunction with the occupancy sensor and associated occupancy task. The detection of occupancy by the occupancy sensor triggers a light harvesting timer that is continuously running. Each time the timer expires, the settings are checked and the lights are brightened or dimmed in accordance thereto. The control unit, via the dimming task, attempts to maintain the light level by dimming or brightening the lights. If the difference is greater than a certain amount, the control unit updates the light level on a quicker basis until the difference falls below the threshold.

Detailed Description Text (72):

To accomplish the update, the user adjusts the light level to the desired level to be maintained. The user then presses the switch on the switch sensor or dimming sensor device. The ambient light sensor then takes a reading of the current light level and sets the maintain lux setting to the new reading. The new maintain lux level setting is sent via the network to the control unit.

Detailed Description Text (76):

The analog 0 to 10 VDC task 247 is similar to the Ballast task 246 except that the 0 and 10 V can be inverted. In addition, the signal can be programmed to accommodate a potentiometer or any other analog input requirement including: 0 to 24 mA, 100 ohm to 20 Kohm resistive and 0 to 10 V analog inputs, 0 to 30 VDC and dry contact digital inputs, 0 to 12 VDC 100 mA source and sink digital outputs and other non-protocol inputs or outputs.

Detailed Description Text (90):

The inhibit task 258 provides the capability of inhibiting and overriding the normal operating mode of one or more devices connected to the communications network. This task is intended to operate within an electrical network that is made up of a plurality of devices wherein a group of devices is capable of commanding the control device to apply and remove electrical power from an electrical load connected to it. The devices or nodes communicate with the control device over the communications network, as described previously.

Detailed Description Text (91):

A block diagram illustrating an example network utilizing a plurality of sensors and a control unit coupled to a load wherein an inhibit signal is communicated to the control unit which supplies a feedback signal to the plurality of sensors is shown in FIG. 12. The sensor devices 290 labeled #1 through #N may comprise any type of sensor such as an occupancy sensor, switch or dimming sensor. Each sensor device 290 is bound (INHIBIT 296) to the control unit 292. The load 294 is connected to the control unit 292. A feedback variable is bound (FEEDBACK 298) from the control unit 292 to each of the sensors 290.

Detailed Description Text (92):

When one of the sensors is turned off, i.e., its switch setting is placed in the OFF position, the inhibit task is operative to inhibit the normal operating mode of all the other input sensors and the control unit. Note that the term 'turning a device off' includes switching the device off, disabling the device, placing the device in standby mode or tripping the device. There can be multiple sensor devices simultaneously in the off, disabled, standby or tripped mode. The control unit and its load remain inhibited until all the sensor devices are no longer in the off, disabled, standby or tripped mode. Thus, electrical power to the load controlled by the control unit remains disconnected until all sensor devices are in the on position.

Detailed Description Text (93):

This feature is particularly suited to permit maintenance or service to be

performed in a safe manner on (1) any of the sensors, i.e., switching, occupancy, dimming, etc. sensor devices, logically connected to the same control unit or on (2) the load physically connected to the control unit or in (3) the circuit breaker.

Detailed Description Text (95):

In either case, when the input device is placed in the off position, an inhibit message is sent to the control unit over the network. In response, electrical power to the attached load is removed. Subsequently, all other sensor devices are inhibited from causing power to be applied to the load. This permits safe access to the control unit and to the load for service or maintenance reasons. The normal operating mode of all the sensor devices connected to the same control unit is inhibited or overridden. Until all sensor devices that have previously been placed in the off mode are put into the on mode and returned to their normal operating condition, all sensor devices are not permitted to change the state of the load or the control unit.

Detailed Description Text (96):

Further details on the implementation of the inhibit task can be found in co-pending U.S. application Ser. No. 09/045,625, filed Mar. 20, 1998 entitled APPARATUS FOR AND METHOD OF INHIBITING AND OVERRIDING AN ELECTRICAL CONTROL DEVICE, similarly assigned and incorporated herein by reference.

Detailed Description Text (98):

The scene task 260 provides a user with a plurality of different scenes from which the control unit can be placed into upon receipt of a command over the network. Scenes provide a user with a limited degree of control over the mode of operation of the control unit. A scene is defined as a set of preferences or options that together change the characteristic operation of the control unit in a desired fashion. The choice of scene is communicated to the control unit from another device, i.e., a network management tool, over the network.

Detailed Description Text (99):

The control unit is adapted to `expose` its internal settings and option selections so as to permit a user to fine tune the behavior of the control unit. In effect, the scene task exposes a pseudo Application programming Interface (API) that a user can `program` to achieve any desired characteristic operation of the device.

Detailed Description Text (100):

Each scene is uniquely numbered, e.g., 0 through 255, and can be selected on demand at any time. Each scene is composed of primitives or parameters defining the behavior of a single option within the device. For example the scene to turn the dimming load off, comprises the necessary primitives to effect the turning off of the triacs which control the dimming load. The control unit can `learn` scenes by sending it a command structured similar to the following:

Detailed Description Text (104):

Table 3 below lists the scenes and their descriptions related to the dimming (triac) capability of the control unit.

Detailed Description Text (105):

Table 3 below lists the scenes and their descriptions related to the dimming (triac) capability of the control unit.

Detailed Description Text (106):

Table 3 below lists the scenes and their descriptions related to the 0 to 10 V control capability of the control unit.

Detailed Description Text (107):

Table 6 below lists the scenes and their descriptions related to the 0 to 10 V

control capability of the control unit.

Detailed Description Text (110):

The scheduler task 249 provides a user with the ability to set scene events which can either be used to control the operation of the control unit, to report to other control units and to affect the overall operation of individual devices as well as the system. An output of type Scene as described earlier can be facilitated to control other control units which do not incorporate scheduling functionality .

Detailed Description Text (113):

The low voltage I/O task 251 provides the user with the ability to select whether the associated I/O is going to be an input or output. This gives the user the flexibility to set or configure the I/O control during run-time as opposed to compile-time. The I/O can be used as a control mechanism whereby the actual data or signal may reside on other serial I/O pins for 0 to 10 VDC and 0 to 20 mA sensing/control. Other examples of low voltage inputs/outputs include: 0 to 24 mA, 100 ohm to 20 Kohm resistive and 0 to 10 V analog inputs, 0 to 30 VDC and dry contact digital inputs, 0 to 12 VDC 100 mA source and sink digital outputs, other non-protocol inputs/outputs, 0 to 10 V ballast, inputs from contact closures and outputs to a relay drive circuit.

Detailed Description Text (114):

Control Unit/Switch/Occupancy State Diagram

Detailed Description Text (115):

A state diagram illustrating the state transitions for a control unit controlling power to a load and coupled via the network to an occupancy sensor and a switch is shown in FIG. 13A. A table illustrating the inputs and outputs of the state transition diagram shown in FIG. 13A is shown in FIG. 13B. The state diagram, generally referenced 300, comprises five states 302, 304, 306, 308 and 310. Two of the states are related to occupancy and two are related to a switch, i.e., from the switch or dimming sensor device. The states represent the state of the feedback signal and whether the load is on or off.

Detailed Description Text (119):

A block diagram illustrating the dimmer switch unit of the present invention is shown in FIG. 14. The dimmer switch unit, generally referenced 320, is an example of another type of device that is part of the control network of the present invention described above. The unit 320 can be adapted to provide on/off control of a load in similar fashion to a conventional non-networked wall switch. In addition, it can be adapted to operate as a dimmer sensor device, providing brighten and dim control over a dimming load. The advantage of the dimmer/switch unit 320 of the present invention is that it is not hardwired to its associated electrical load. The unit has the capability of communicating over the network to other devices. Typically, the unit 320 would be bound (in LonWorks terminology) to a control unit 60 (FIG. 3) described previously. The commands generated by the dimmer/switch unit are received and interpreted by the tasks within the control unit with the load being effected accordingly.

Detailed Description Text (120):

The dimmer/switch unit 320 comprises a controller 340 at its core. The controller 340 functions similarly to the controller 90 in the control unit. Thus, a detailed description of the controller 340 will not be repeated here. The controller 340 comprises a service pin to which is connected a momentary push button switch 326 and service indicator 324 which may comprise an LED. The switch 326 is connected between ground and the cathode of the LED 324. The anode of the LED is connected to Vcc via resistor 322. A zener diode 328 clamps the voltage on the service pin to a predetermined level. The switch 326 is connected to the service pin via a series resistor 346. The service pin on the controller functions as both an input and an output. The controller 340 is adapted to detect the closure of the switch 326 and

to perform service handling in response thereto.

Detailed Description Text (122):

The reset circuitry 334 functions similarly to that of reset circuitry 62 (FIG. 3). The clock circuitry 336 also functions similarly to the clock circuitry 64 (FIG. 3). The power supply 338 can be adapted to generate the required voltages, e.g., V.sub.CC, 15 V, etc. directly from the phase and neutral. In the alternative, the power supply can be adapted to generate power from the 15 V output from the control unit. This simplifies the power supply circuitry that is required in the dimmer/switch unit.

Detailed Description Text (124):

As described above, the dimmer/switch unit 320 interoperates with other devices on the network, particularly the control unit. The communication means within the device comprises a communication transceiver 342 that interfaces the controller 340 to the network. The communications transceiver 342 functions similarly to the communication transceiver 92 (FIG. 3) and may comprise any suitable communication/network interface means. The choice of network, e.g., LonWorks, CEBus, etc. in addition to the choice of media, determines the requirements for the communications transceiver 342. Using the LonWorks network as an example, the communications transceiver 342 may comprise the FTT-10A twisted pair transceiver manufactured by Echelon Corp. This transceiver comprises the necessary components to interface the controller to a twisted pair network. Transmit data from the controller 340 is input to the transceiver which functions to encode and process the data for placement onto the twisted pair cable. In addition, data received from the twisted pair wiring is processed and decoded and output to the controller 340. Transceivers for other types of media such as power line carrier, coaxial, optical fiber, etc. can also be used without departing from the spirit of the present invention.

Detailed Description Text (126):

The dimmer/switch unit 320 also comprises an LED display circuit 344 that functions to provide a user with a visual indication. The LED display circuit 344 is connected to a plurality of I/O ports on the controller via multiple signal lines.

Detailed Description Text (127):

In addition, non-protocol I/O devices can be attached to the unit 320 via one or more I/O lines into the controller 340. This permits non-protocol devices to be controlled and to share information among protocol enabled devices on the network.

Detailed Description Text (128):

A schematic diagram illustrating the LED display circuitry of the dimmer switch unit in more detail is shown in FIG. 15. The LED display circuitry comprises a plurality of LED elements 382. The cathode of each LED is connected to an I/O port on the controller via a signal line. The signal lines are labeled LED #1 through LED #N. Any number N of LEDs can be used to form an array or other suitable visual pattern. The anode of each LED is connected to the emitter of transistor 380. The collector of transistor 380 is connected to V.sub.CC and the base is connected to the controller via signal line LED\_DIM. For an LED to be illuminated, the particular signal line LED must be active low while the transistor 380 is turned on. Thus, by individually controlling the LED signal lines, any combination or pattern of LEDs 382 can be illuminated.

Detailed Description Text (130):

The LED display circuitry 344 can be used in a variety of applications. One application is to display the dimming level that will be used the next time a 'turn on' command is received. This can be displayed when the lights are in the off state. In addition, the brightness level of the LEDs themselves can be dimmed to indicate that the lights are currently off. The LEDs can also be illuminated in a 'wave' type pattern so as to provide an illusion to the user that the light bar

follows the actual lighting level being controlled. The `wave` pattern is accomplished by illuminating the LEDs in a multiplexed fashion as well as allowing for one or more LEDs to be illuminated at a single time.

Detailed Description Text (134):

A block diagram illustrating the software portion of the dimmer control unit in more detail is shown in FIG. 16. The hardware and software components of the dimmer/switch unit in combination implement the functionality of the device. The software portion of the dimmer/switch unit will now be described in more detail. Note that the implementation of the software may be different depending on the type of controller used to construct the dimmer/switch unit. The functional tasks presented herein, however, can be implemented regardless of the actual controller and/or software methodology used. In the example presented herein, the controller comprises a Neuron 3120, 3150 processor or equivalent. Some of the functionality required to implement the dimmer/switch unit is incorporated into the device by the manufacturer. For example, the processing and associated firmware for implementing the physical, link and network layers of the communication stack are performed by means built into the Neuron processor. Thus, non-Neuron implementations of the dimmer/switch unit would require similar communication means to be able to share information with other devices over the network.

Detailed Description Text (140):

The inhibit task 394 provides the capability of inhibiting and overriding the normal operating mode of the dimmer/switch unit itself and other devices connected to the communications network. This task is intended to operate within an electrical network made up of a plurality of devices wherein a group of devices such as the dimmer/switch unit are capable of commanding a control device to disable electrical power from an electrical load. The devices or nodes communicate with the control device over the communications network. The inhibit mode is activated by a user placing the switch 330 in the OFF position. The inhibit task 394 functions similarly to the inhibit task 258 (FIG. 9) discussed in detail above. Thus, a detailed description will not be repeated here.

Detailed Description Text (146):

The dimming task 400 implements the dimming functionality of the unit. A more detailed discussion of the dimming features of the system was presented above in connection with FIG. 11 and the dimming task 244 (FIG. 9). The dimming sensors 280 (FIG. 11) labeled #1 through #N may comprise the dimmer/switch unit 320. Each dimmer/switch unit is bound to the control unit via the network.

Detailed Description Text (147):

On each of the dimming sensors, the brightness level is adjusted by pressing a rocker switch which comprises the dim switch 358 and the brighten switch 360. Pressing up on the rocker switch increases the brightness level by an incremental amount, e.g., 1/2 or 1 full unit of resolution. When the rocker switch is pressed up, the controller detects the contact closure and a command is sent from the dimming sensor to the control unit that it is bound to. To dim the light, the switch is pressed in the down direction.

Detailed Description Text (148):

As was described previously, the dimmer/switch unit has a network variable bound to it from the control unit. The network variable comprises a feedback signal from the control unit to each dimmer/switch unit associated with a particular load connected to the control unit. The feedback signal keeps each dimmer/switch as to the state of the load. Thus, all the devices are kept informed with the current state of the load that may comprises the brightness level of the load among other quantities.

Detailed Description Text (150):

The power on/off task 402 functions similarly to the dimming task, with the difference being that the load is turned off and on rather than dimmed and

brightened. Similar to the case of dimming, the on/off control of a load also may include binding a feedback variable to all the dimmer/switch units bound to a particular load connected to the control unit.

Detailed Description Text (151):

A diagram illustrating a dimmer/switch sensor unit suitable for use with the control system of the present invention is shown in FIG. 17. The dimmer/switch sensor unit 320 is adapted to fit a single gang wall receptacle box. A Decora style cover plate 540 installs over the dimmer/switch sensor. The rocker 544 can be pressed in either the up or downward direction. Pressing the rocker 544 in the downward direction actuates switch 358 (FIG. 14). Pressing the rocker 544 in the upward direction actuates switch 360.

Detailed Description Text (152):

The LED display 542 provides a user with a visual indication as generated by the sensor 320. In this embodiment, six LED elements are arranged in a vertical line. If the sensor unit 320 is configured as a dimmer, the LEDs 542 can be used to indicate the brightness level of the load. Other arrangements and control schemes for the LEDs are also possible..

Detailed Description Text (154):

A block diagram of the occupancy/ambient light-sensing unit of the present invention is shown in FIG. 18. The occupancy/ambient light sensing unit, generally referenced 410, is yet another example of the type of device that can be part of the control network of the present invention. The unit 410 is operative to detect motion within an area defined as the field of view of the unit. An advantage of the occupancy/ambient light sensing unit 410 of the present invention is that it is not hardwired to its associated electrical load. The unit has the capability of communicating over the network to other devices. Typically, the unit 410 would be bound to the control unit 60 (FIG. 3), described previously. The commands generated by the occupancy/ambient light sensing unit are received and interpreted by the tasks within the control unit with the load being effected accordingly.

Detailed Description Text (155):

The occupancy/ambient light sensing unit 410 comprises a controller 440 that functions similarly to the controller 90 in the control unit. Thus, a detailed description of the controller 440 will not be repeated here. The controller 440 comprises a service pin to which is connected a momentary push button switch 416 and service indicator 414 which may comprise an LED. The switch 416 is connected between ground and the cathode of the LED 414. The anode of the LED is connected to V.sub.CC via resistor 412. A zener diode 418 clamps the voltage on the service pin to a predetermined level. The switch 416 is connected to the service pin via a series resistor 420. The service pin on the controller functions as both an input and an output. The controller 440 is adapted to detect the closure of the switch 416 and to perform service handling in response thereto.

Detailed Description Text (157):

The reset circuitry 428 functions similarly to that of reset circuitry 62 (FIG. 3). The clock circuitry 430 also functions similarly to the clock circuitry 64 (FIG. 3). The power supply 432 can be adapted to generate the required voltages, e.g., V.sub.CC, 15 V, etc. directly from the phase and neutral. In the alternative, the power supply can be adapted to generate power from the 15 V output from the control unit. This simplifies the power supply circuitry that is required in the dimmer/switch unit.

Detailed Description Text (159):

As described above, the occupancy/ambient light sensing unit 410 interoperates with other devices on the network, particularly the control unit. The communication means within the device comprises a communication transceiver 452 that interfaces the controller 440 to the network. The communications transceiver 452 functions

similarly to the communication transceiver 92 (FIG. 3) and may comprise any suitable communication/network interface means. The choice of network, e.g., LonWorks, CEBus, etc. in addition to the choice of media, determines the requirements for the communications transceiver 452. Using the LonWorks network as an example, the communications transceiver 452 may comprise the FTT-10A twisted pair transceiver manufactured by Echelon Corp, Palo Alto, Calif. This transceiver comprises the necessary components to interface the controller to a twisted pair network. Transmit data from the controller 440 is input to the transceiver which functions to encode and process the data for placement onto the twisted pair cable. In addition, data received from the twisted pair wiring is processed and decoded and output to the controller 440. Transceivers for other types of media such as power line carrier, coaxial, optical fiber, etc. can also be used without departing from the spirit of the present invention. Alternatively, the control unit functionality can be employed within the sensor devices themselves.

Detailed Description Text (163):

In addition, non-protocol I/O devices can be attached to the unit 410 via one or more I/O lines into the controller 440. This permits non-protocol devices to be controlled and to share information among protocol enabled devices on the network.

Detailed Description Text (173):

The inhibit task 524 provides the capability of inhibiting and overriding the normal operating mode of the occupancy/ambient light sensor unit itself and other devices connected to the communications network. This task is intended to operate within an electrical network made up of a plurality of devices wherein a group of devices such as the occupancy/ambient light sensor unit are capable of commanding a control device to disable electrical power from an electrical load. The devices or nodes communicate with the control device over the communications network. The inhibit mode is activated by a user placing the 424 in the OFF position. The inhibit task 524 functions similarly to the inhibit task 258 (FIG. 9) discussed in detail above. Thus, a detailed description will not be repeated here.

Detailed Description Text (179):

The occupancy task 530 is used to detect occupancy and maintain the occupied state until no occupancy is detected. The occupancy task 530 implements the occupancy functionality of the unit. A more detailed discussion of the occupancy features of the system was presented above in connection with FIG. 10 and the occupancy task 256 (FIG. 9). The occupancy task is used in conjunction with the digitized OCCUPANCY signal output of the motion sensor circuitry 448 (FIG. 19). The occupancy feature can be used to detect occupancy in a room or an area. Typically, the output generated by the occupancy task is bound to the control unit, which controls electrical power to the load. The occupancy task performs the motion detection function and calculates application delay and/or hold times as required. Note that more than one occupancy sensor may be bound to the same load. In addition, the SNVT 'SNVT occupancy' can be used in implementing the occupancy detection and reporting functions.

CLAIMS:

5. The local operating network according to claim 1, wherein said electrical device comprises a control unit adapted to control an electrical load in accordance with information received over said communications network from one or more said electrical devices.
6. The local operating network according to claim 5, wherein said control unit comprises relay control means for controlling electrical power in on/off fashion to a relay load electrical coupled to said control unit.
7. The local operating network according to claim 5, wherein said control unit comprises dimming control means adapted to brighten and dim a dimming load

electrically coupled to said control unit.

8. The local operating network according to claim 5, wherein said control unit comprises ballast control means adapted to generate a 0 to 10 volt light level control signal for brightening and dimming a fluorescent electronic ballast electrically coupled to said control unit.

9. The local operating network according to claim 5, wherein said control unit comprises motor control means for controlling electrical power to a motor load coupled to said control unit.

10. The local operating network according to claim 5, wherein said control unit comprises low voltage analog control means operative to generate a 0 to 10 volt analog signal for input to an analog load coupled to said control unit.

11. The local operating network according to claim 5, wherein said control unit comprises interface means for interfacing said control unit to non-protocol devices.

19. The local operating network according to claim 5, wherein one or more of said electrical devices comprises ballast software application code for controlling the light level of a plurality of fluorescent lights connected to said control unit.

21. The local operating network according to claim 5, wherein one or more of said electrical devices comprises reset software application code for placing said control unit into an initialization state.

22. The local operating network according to claim 5, wherein one or more of said electrical devices comprises go unconfigured software application code for placing said control unit in an unconfigured state.

23. The local operating network according to claim 1, wherein one or more of said electrical devices comprises communication input/output (I/O) software application code for receiving data from and/or transmitting data to said communications network.

26. The local operating network according to claim 5, wherein one or more of said electrical devices comprises scheduler software application code for providing a user with the ability to set scene events for controlling the operating of said control unit.

27. The local operating network according to claim 5,

wherein the control unit includes pin means; and

wherein one or more of said electrical devices comprises low voltage input/output (I/O) software application code for providing the user the ability to set whether the pin means of the control unit functions as an input or an output.

34. A control unit for use in a local operating network, said control unit comprising:

load control means adapted to control electrical power to a load electrically connected to said control unit;

a communications transceiver for transmitting and receiving data between said control unit and said local operating network, with the local operating network including:

a communications network; and

a plurality of electrical devices operatively connected to the communications network, each electrical device adapted to perform a first function,

wherein function-specific information is generated by a first electrical device having the associated first function,

wherein such function-specific information is transmitted to the plurality of electrical devices over the communications network, and

wherein such function-specific information is received by a second electrical device adapted to detect such function-specific information over the communications network and to respond to such function-specific information to perform a second function associated with the first function;

memory means for storing software application code;

a controller adapted to execute one or more software applications stored in said memory means, said controller, in combination with said one or more software applications, operative to receive the function-specific information over said local operating network from one or more electrical devices and to control said load control means in accordance thereto, said controller also operative to transmit the function-specific information over said local operating network to one or more electrical devices;

power supply circuitry electrically coupled to a source of electrical power, said power supply circuitry adapted to generate one or more voltages for use by said control unit and an output voltage for use by a plurality of external electrical devices.

35. The control unit according to claim 34, wherein said load control means comprises ballast dimming circuitry operative to provide a 0 to 10 V signal suitable for use by an electronic ballast electrically connected thereto.

36. The control unit according to claim 34, wherein said load control means comprises relay driver circuitry operative to turn an electrical relay on and off, said relay electrically connected to a relay load.

37. The control unit according to claim 34, wherein said load control means comprises dimming circuitry operative to brighten and dim a lighting load electrically connected thereto.

38. The control unit according to claim 34, wherein said load control means comprises motor drive circuitry operative to control an electrical motor.

39. The control unit according to claim 34, wherein said load control means comprises low voltage analog drive circuitry operative to provide an analog low voltage signal for use by an analog load electrically connected to said control unit.

40. The control unit according to claim 34, further comprising input/output (I/O) means for interfacing said control unit to one or more non-protocol devices.

41. The control unit according to claim 34, wherein said one or more software applications comprises relay software application code for controlling the on/off state of one or more relays connected to said control unit.

42. The control unit according to claim 34, wherein said one or more software applications comprises occupancy software application code for controlling an electrical load in accordance with the detection of motion in an area.

43. The control unit according to claim 34, wherein said one or more software applications comprises lumens maintenance software application code for driving a dimming output level to less than maximum to yield a reduction in energy consumption.

44. The control unit according to claim 34, wherein said one or more software applications comprises dimming software application code for providing dimming and brightening control of a dimming load.

45. The control unit according to claim 34, wherein said one or more software applications comprises California Title 24 software application code for modifying relay and dimming functionality in accordance with the statute thereof.

46. The control unit according to claim 34, wherein said one or more software applications comprises ambient light level software application code for maintaining a particular light level within an area.

47. The control unit according to claim 46, wherein said one or more software applications comprises light harvesting software application code for maintaining the light level by dimming or brightening the lighting load.

48. The control unit according to claim 34, wherein said one or more software applications comprises ballast software application code for controlling the light level of fluorescent lights connected to said control unit.

49. The control unit according to claim 34, wherein said one or more software applications comprises low voltage analog occupancy software application code for generating a low voltage analog signal output to an analog load.

50. The control unit according to claim 34, wherein said one or more software applications comprises reset software application code for placing said control unit into an initialization state.

51. The control unit according to claim 34, wherein said one or more software applications comprises go unconfigured software application code for placing said control unit in an unconfigured state.

52. The control unit according to claim 34, wherein said one or more software applications comprises communication input/output (I/O) software application code for receiving data from and/or transmitting data to said communications network.

53. The control unit according to claim 34, wherein said one or more software applications comprises inhibit software application code for inhibiting and overriding the normal operating mode of said control unit.

54. The control unit according to claim 34, wherein said one or more software applications comprises scene mode software application code for providing a user with a plurality of scenes into which said control unit can be placed via a command transmitted over said communications network.

55. The control unit according to claim 34, wherein said one or more software applications comprises scheduler software application code for providing a user with the ability to set scene events for controlling the operating of said control unit.

56. The control unit according to claim 34,

wherein the controller includes pin means; and

wherein said one or more software applications comprises low voltage input/output (I/O) software application code for providing the user the ability to set whether the pin means on said controller functions as an input or an output.

57. The control unit according to claim 37, wherein said dimming circuitry comprises:

a triac circuit adapted to receive a dimming signal representing the desired light level, said triac circuit adapted to brighten or dim said lighting load in response to said dimming signal;

a relay connected in series with said triac circuit, said relay operative to provide an air gap so as to disconnect electrical power from said dimming load; and

zero detect circuitry electrically coupled to said source of electrical power, said zero detect circuitry operative to detect the zero crossings of said electrical power and generate a signal in accordance thereto.

58. The control unit according to claim 34, wherein said memory means comprises random access memory (RAM).

59. The control unit according to claim 34, wherein said memory means comprises read only memory (ROM).

60. The control unit according to claim 34, wherein said memory means comprises electrically erasable programmable read only memory (EEPROM).

61. The control unit according to claim 34, wherein said communications transceiver comprises a twisted pair wiring transceiver.

62. The control unit according to claim 34, wherein said communications transceiver comprises a radio frequency (RF) transceiver.

63. The control unit according to claim 34, wherein said communications transceiver comprises a power line carrier transceiver.

64. The control unit according to claim 34, wherein said communications transceiver comprises an infrared (IR) transceiver.

65. The control unit according to claim 34, wherein said communications transceiver comprises an optical fiber transceiver.

66. The control unit according to claim 34, wherein said communications transceiver comprises a coaxial cable transceiver.

67. The control unit according to claim 34, wherein said communications transceiver comprises a twisted pair wiring transceiver.

68. The control unit according to claim 34, wherein said controller comprises an integrated circuit.

69. The control unit according to claim 34, wherein said controller comprises a microcontroller including an integrated circuit.

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L5: Entry 1 of 1

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## ABSTRACT:

Screen data is generated by a screen generating processor (74) of a control host computer (7) and transmitted to a programmable display apparatus (5). In accordance with the screen data, the programmable display apparatus (5) inquires a PLC (3) or the like about a state of a device (21), so as to update the display or transmit a

control instruction depending on an input result. On the other hand, a control host computer (7) has a public server section (77) to transmit to a client apparatus (9) via the Internet an applet, which is generated by a compiler (76) compiling the screen data. The client apparatus (9) executes the applet to transmit to the public server section (77) an or the control instruction inquiry similar to those the programmable display apparatus (5) makes. In this way, the display is updated in accordance with a response. This realizes a control system, which allows a display content of the programmable display apparatus (5) to be remotely checked from a remote area remote from the programmable display apparatus (5), without newly generating a display screen.

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L5: Entry 1 of 1

File: PGPB

Sep 18, 2003

DOCUMENT-IDENTIFIER: US 20030177440 A1

TITLE: Control server, control terminal, control system, and recording medium storing control communication programAbstract Paragraph:

Screen data is generated by a screen generating processor (74) of a control host computer (7) and transmitted to a programmable display apparatus (5). In accordance with the screen data, the programmable display apparatus (5) inquires a PLC (3) or the like about a state of a device (21), so as to update the display or transmit a control instruction depending on an input result. On the other hand, a control host computer (7) has a public server section (77) to transmit to a client apparatus (9) via the Internet an applet, which is generated by a compiler (76) compiling the screen data. The client apparatus (9) executes the applet to transmit to the public server section (77) an or the control instruction inquiry similar to those the programmable display apparatus (5) makes. In this way, the display is updated in accordance with a response. This realizes a control system, which allows a display content of the programmable display apparatus (5) to be remotely checked from a remote area remote from the programmable display apparatus (5), without newly generating a display screen.

Summary of Invention Paragraph:

[0001] The present invention relates (a) to a control server and a control terminal for use in a control system having a programmable display apparatus, and for checking/controlling (checking and/or controlling) display contents of the programmable display apparatus from a remote location without generating a new display-use screen, (b) to the control system having those, and (c) to a control communication program for use in the control system.

Summary of Invention Paragraph:

[0003] Moreover, a display apparatus placed in a vicinity of the PLC is used for displaying data from each PLC or for giving control instructions to the PLCs. A programmable display apparatus, which is an HMI (Human Machine Interface) apparatus, is widely used as the display apparatus in recent years, instead of control panels for giving the control instructions to the PLCs, and display lamps for indicating working states of the PLCs. Apart from this, a control system is, in some cases, arranged such that the control system can be displayed or operated also by a control host computer located in a remote location remote from those display apparatus.

Summary of Invention Paragraph:

[0004] Specifically, for example, as shown in FIG. 44, PLCs 503 has a central role of controlling in a conventional control system 501. Each PLC 503 is connected to a control-object apparatus (an apparatus to be controlled) 521a and a sensor 521b of a target system 502, and a programmable display apparatus 505 for displaying and for giving control instructions. Further, the PLC 503 is connected to other PLCs 503 and a control host computer 507 via a serial cable 504. Sending and receiving of control data between the PLC 503 and the control host computer 507, and between the respective PLCs 503 are carried out by using a communication function of the

PLCs 503.

Summary of Invention Paragraph:

[0005] In this arrangement, a display processor 571 of the control host computer 507 communicates with the PLC 503 to receive data that represents a state of the target system 502, then displays a screen in accordance with the state, and sends the control data to the PLC 503 in accordance with input by a user. The target system 502 is controlled in accordance with the control data. Similarly, the programmable display apparatus 505 displays/controls the state of the target system 502, while communicating with the PLC 503.

Summary of Invention Paragraph:

[0006] The above arrangement, however, requires that the screen for the display processor 571 of the control host computer 507 be generated, besides a screen for the programmable display apparatus 505. This arises not only a problem that the generation of the screen is necessary but also a problem that the control host computer 507 cannot check the screen displayed on the programmable display apparatus 505.

Summary of Invention Paragraph:

[0007] Specifically, the programmable display apparatus 505 carries out displaying/controlling in accordance with screen data. The screen data is composed by combining information, where a unit of information is information that represents corresponding relationship between positional information for specifying an area on a base screen, and an address of a device that corresponds to a display or input onto the area. The screen, data is generated by an image processor 572 of the control host computer 507, and then is delivered to each programmable display apparatus 505.

Summary of Invention Paragraph:

[0008] Moreover, the control system 501, which is basically a closed system, does not allow seeing the state of the control system, such as the screen of the programmable display apparatus, from a remote location. Arts of seeing states of control apparatuses and the like via the Internet from a remote location are disclosed, for example, in U.S. Pat. No. 5,805,442 (Grant date: Sep. 8, 1998), International Patent Publication No. WO 99/13388 (published on Mar. 18, 1999), and International Patent Publication No. WO 99/13418 (published on Mar. 18, 1999). However, the above problem cannot be solved even by the arts of the Patents.

Summary of Invention Paragraph:

[0009] On the other hand, since the control host computer 507 has different usage and a different installation location from those of the programmable display apparatus 505, the control host computer 507 and the programmable display apparatus 505 are different from each other in terms of (a) hardware arrangements, such as CPUs and memory maps and (b) software arrangements, such as operating systems. Therefore, the display processor 571 cannot display/control in accordance with the screen data of the programmable display apparatus 505. Thus, the display processor 571 generates a display-use screen of its own. Moreover, it is necessary to go to the installation location of the programmable display apparatus 505 in order to check display contents of the programmable display apparatus 505.

Summary of Invention Paragraph:

[0011] In the control system 501, for updating the control program, a programmer of the control program needs to go near to the control host computer 507 and the PLC 503 so as to operate the control host computer 507 connected to the PLC 503. This arises a problem that updating of program is troublesome.

Summary of Invention Paragraph:

[0015] The present invention has an object to realize a control system in which it is possible to check display contents of a programmable display apparatus from a

remote location remote from the programmable display apparatus without generating a new display-use screen. Moreover, the present invention has another object to realize a control terminal with which it is possible to update a control program of a control unit from the remote location, by still using a conventional control program generating means.

Summary of Invention Paragraph:

[0016] (1) A control server apparatus of the present invention, in order to attain the objects, is provided with a display apparatus-end communication section, connected to a programmable display apparatus, for receiving data indicating a screen of the programmable display apparatus; a converting section for converting the thus received data into a format that is displayable for a terminal apparatus; and a terminal-end communication section for communicating with the terminal apparatus via a network so as to transmit the data thus converted into the format by the converting section.

Summary of Invention Paragraph:

[0017] In the above arrangement, the converting section converts the data into the format that is displayable for a terminal apparatus, when the display apparatus-end communication section receives the data from the programmable display apparatus. Then, the terminal-end communication section transmits, to the terminal apparatus via a network, such as the Internet, the data thus converted in terms of format. Here, the display apparatus-end communication section of the control server apparatus is directly connected with the programmable display apparatus, without having therebetween a control apparatus for controlling a device. Thus, an amount of communication of the control apparatus will not be increased even though the data indicting the screen of the programmable display apparatus is transmitted, on contrary to a case where the programmable display apparatus and the control server apparatus are connected via the control apparatus. This does not burden the control apparatus.

Summary of Invention Paragraph:

[0018] The control server apparatus is preferably so arranged as to be used in a control system including programmable display apparatuses (i) for acquiring contents of addresses of devices in accordance with screen data composed of a combination of (a) the addresses of the devices corresponding to displays displayed on regions on a screen, and (b) processing instruction words for indicating corresponding relationship between the addresses of the devices and the regions on the screen, and (ii) for displaying the states of the devices on the regions on the screen in accordance with the contents, and as to be provided with a terminal-end communication section capable of communicating with a terminal apparatus; and a converting section for converting the screen data so as to generate a program for inquiring about the contents of the addresses to the terminal-end communication section, and for displaying the states of the devices according to how the terminal-end communication section responds, on one of screen regions of the terminal apparatus that corresponds to a screen region indicated by the screen data, the terminal-end communication section transmitting the program thus generated by the converting section, and acquiring the content of the address that the program is to inquire about, and transmitting to the terminal apparatus the content of the address.

Summary of Invention Paragraph:

[0019] In the above arrangement, the terminal-end communication section of the control server apparatus transmits the program that is generated from the screen data by the converting section. On the other hand, a translating section of the terminal apparatus inquires, in accordance with the program, inquires the terminal-end communication section about the contents of the addresses. When the terminal-end communication section acquires the contents of the addresses and transmits the content to the terminal apparatus, the translating section displays the states of the devices according to how the terminal-end communication section responds, on

the one of screen regions of the terminal apparatus that corresponds to the screen region indicated by the screen data.

Summary of Invention Paragraph:

[0020] As a result, the terminal apparatus can display the screen of the content identical to that of the display screen of the programmable display apparatus, without any trouble, as long as the programmable display apparatus can communicate with the terminal-end communication section, for example, even if the programmable display apparatus is accessing the terminal-end communication section from a remote area via the Internet. Moreover, the program for performing the actions mentioned above is delivered from the control server apparatus, thereby eliminating a need of installing in advance a program for display, and reducing a labor and cost of the installing.

Summary of Invention Paragraph:

[0021] Furthermore, because the converting section generates the program from the screen data, it is not necessary to generate a screen for the terminal apparatus, thereby significantly reducing a labor for generating the screen. Moreover, when the screen data for a remote area is not generated besides that for the programmable display apparatus, the screen of the remote area and that of the programmable display apparatus are always identical to each other. Thus, labor of administration is significantly reduced, compared with a case where the screen data for the remote area and that for the programmable display apparatus are separately generated and administered to be identical always.

Summary of Invention Paragraph:

[0022] The control server apparatus is so arranged that each programmable display apparatus includes (a) a designated protocol communication section for communicating with a control apparatus for controlling a device in a designated protocol that is designated to the control apparatus, (b) a common protocol communication section for communicating, regardless of which type the control apparatus is of, in a common protocol that is preset, and (c) a relay section for relaying communication in the designated protocol and communication in the common protocol by converting the protocols from one to the other, and the terminal-end communication section, when the addresses of the devices indicate which of the devices is to be controlled by the control apparatus, (i) transmits an inquiry that inquires the contents of the addresses, in the common protocol to that programmable display apparatus that is connected to the control apparatus, and (ii) acquires the contents of the addresses according to how the programmable display apparatus responds in the common protocol.

Summary of Invention Paragraph:

[0023] In the above arrangement, the programmable display apparatus relays the communication between the designated protocol and the common protocol. As a result, regardless of which designated protocol the terminal apparatus uses, the terminal-end communication section can acquire the content of the address of the device simply by communicating, in the common protocol, with the programmable display apparatus to which the control apparatus is connected. Thus, it is possible to reduce a labor for generating the terminal-end communication section, compared with a case where the communication is carried out in designated protocols respectively designated to control apparatuses.

Summary of Invention Paragraph:

[0024] Another control server apparatus of the present invention is preferable so arranged as to be used in a control system including programmable display apparatuses, in accordance with screen data composed of a combination of (a) addresses of devices corresponding to displays on regions on a screen, (b) addresses of devices corresponding to inputs entered onto the regions on the screen, and (c) processing instruction words for indicating corresponding relationship between the addresses and the regions of the screen, for changing, in

response to the inputs, that contents of the addresses of the devices that correspond to the regions onto which the inputs are entered, and as to be provided with a terminal-end communication section capable of communicating with a terminal apparatus; and a converting section for converting the screen data so as to generate a program for giving an instruction to the terminal-end communication section, in response to an input entered onto a screen region of the terminal apparatus that is indicated by the screen data, the instruction for changing the contents of the addresses, the terminal-end communication section transmitting to the terminal apparatus the program generated by the converting section, and changing that contents of the addresses that are indicated by the instruction for changing the contents of the addresses.

Summary of Invention Paragraph:

[0026] As a result, the terminal apparatus can control the operation of the device on the screen of the content same as that of the display screen of the programmable display apparatus, without any trouble, as long as the programmable display apparatus can communicate with the terminal-end communication section, for example, even if the programmable display apparatus is accessing the terminal-end communication section from a remote area via the Internet. Furthermore, because the converting section generates the program from the screen data, and causes the terminal apparatus to execute the program, as in the above arrangement, it is not necessary to generate a screen for the terminal apparatus, thereby significantly reducing a labor for generating and administrating the screen, and a labor and a cost for installation.

Summary of Invention Paragraph:

[0027] Moreover, the control server apparatus is different in that the control sever apparatus used in the control system and the terminal-end communication section transmit in the common protocol the instruction for changing the contents of the addresses, to the programmable display apparatus to which the control apparatus is connected, when the addresses of the devices indicate which of the devices is to be controlled by the control apparatus.

Summary of Invention Paragraph:

[0028] Therefore, regardless of which designate protocol the terminal apparatus uses, the terminal-end communication section can change the content of the address of the device simply by communicating, in the common protocol, with the programmable display apparatus connected with the control apparatus. As a result, it is possible to reduce a labor for generating the terminal-end communication section, compared with a case where the communication is carried out in designated protocols respectively designated to control apparatuses.

Summary of Invention Paragraph:

[0029] Moreover, the respective control server apparatuses are preferably arranged that the terminal-end communication section communicates with the terminal apparatus via the Internet. This does not need communication cost, which depends on a distance between the control server apparatus and the terminal apparatus, unlike a case of communication via a public telephone line of the circuit switched connection system. Moreover, this enables a support staff of the control system to display/control by operating the terminal apparatus in a location connectable to the Internet, as by operating the programmable display apparatus. As a result, it is possible to maintain the control system without having the support staff of the control system in a vicinity of the control server apparatus.

Summary of Invention Paragraph:

[0030] A control system of the present invention is provided with the programmable display apparatuses including (a) the designated protocol communication, (b) the common protocol communication section, and (c) the relay section; and a control server apparatus including (d) a display apparatus-end communication section, connected to the programmable display apparatuses, for receiving data indicating

screens of the programmable display apparatuses, (e) a converting section for converting the thus received data into a format that is displayable for a terminal apparatus, and (f) a terminal-end communication section for communicating with the terminal apparatus via a network so as to transmit the data that is converted into the format by the converting section.

Summary of Invention Paragraph:

[0031] With the above arrangement, in which the programmable display apparatus converts the designated protocol and the common protocol from one to the other as does the aforementioned control server apparatus, the control-server apparatus can communicate in the common protocol, regardless of which designated protocol the terminal apparatus uses. This eliminates a labor of subscribing a new control apparatus in the control system. Moreover, because the control server apparatus receives data indicting the screen of the programmable display apparatus, converts the data in terms of the format, and transmit the data to the terminal apparatus, it is possible to display, on a terminal apparatus in a remote area, the screen having the same content as that of the display screen of the programmable display apparatus, without putting a burden on the control apparatus.

Summary of Invention Paragraph:

[0032] (2) A control terminal apparatus of the present invention, in order to attain the objects, is provided with a wide area network communication section of being connected, via a wide area network, to a local control system including a control unit for controlling a control object in accordance with a control program, and a control display apparatus for communicating with the control unit so as to display or control a control state of the control unit; and a serial port simulating section for presetting which local control system having a control unit that is to receive the control program, and for receiving, as a proxy of a serial port, the control program which a control program generating section outputs to a serial port, and transmits, to the local control system, instruction data indicating the control program and the control unit to receive the control program, so as to instruct the wide area network communication section to give an instruction for updating the control program.

Summary of Invention Paragraph:

[0033] In the above arrangement, the serial port simulating section receives the control program as the proxy of the serial port, when the control program generating section is about to output the control program to the serial port. Then, the serial port simulating section instructs the wide areas communication section to send to a preset local control system the instruction data indicating a control unit and a control program to receive the control program. On the other hand, the local control system updates, with the control data indicated by the instruction data, the control program of the control unit specified by the instruction data, when the local control system receives the instruction data via the wide area network such as the Internet.

Summary of Invention Paragraph:

[0034] A control system of the present invention is provided with the control terminal apparatus, and a local control system including a control unit for controlling a control object in accordance with a control program, and a control display apparatus for displaying or controlling a control state of the control unit, the control display apparatus having (a) a designated protocol communication section for communicating via the serial interface in a designated protocol designated to a type of the control unit so as to display or control the control state of the control unit, (b) a common protocol communication section for communicating with a network other than the serial interface, regardless of which type the control apparatus is of, in a common protocol that is preset, and (c) a relay section for relaying communication between the designated protocol section and the common protocol section, the local control system including a display apparatus specifying section for specifying, via the wide area network, the control

display apparatus connected to the control unit to receive the control program, in accordance with instruction data, which the local control system receives from the wide area network, and instructing, in the common protocol and via the network, the control display apparatus to update the control program.

Summary of Invention Paragraph:

[0035] In the above arrangement, when the control terminal apparatus transmits the instruction data, the display apparatus specifying section of the local control system specifies the control display apparatus, to which the control unit to receive the control program is connected, in accordance with the instruction data. Then, the display apparatus specifying section instructs, in the common protocol, the control display apparatus to update the control program. On the other hand, in the control display apparatus, that instruction to update the control program, which is received by the common protocol communication section, is relayed by the relay section, and transferred to the control unit via the designated protocol communication section and the serial interface. In this way, the control program of the control unit is updated.

Summary of Invention Paragraph:

[0036] In the above arrangement, the communication in the designated protocol designated to the control unit and the communication in the common protocol are relayed by the control apparatus, which is requisite to the local control system, and which possesses enough processing capacity and communication capacity, as compared with the control unit, because the control apparatus communicates with a user when displaying/controlling. Because of this, the display apparatus specifying section can instruct the updating of the control program, always in the common protocol, even in a case where control units of different types coexist in the local control system, and in case where a control unit of a new type is added to the local control system. Thus, regardless of which type of control unit the reception end uses, it is possible to reduce labor for manufacturing the display apparatus specifying section.

Summary of Invention Paragraph:

[0037] (3) A control system of the present invention, in order to attain the objects, is so arranged as to be provided with an acquiring section for displaying a state of a device on a display-use screen that has been generated in advance, and for acquiring screen data and device data from a control display apparatus for giving a control instruction for the device via the display-use screen, the screen data being for the display-use screen, and device data indicating a state of the device; a generating section for generating terminal-use data for displaying the display-use screen on a display surface of the terminal apparatus, in accordance with the screen data and device data thus acquired; and a communication section for communicating with the terminal apparatus via a network so as to transmit the terminal-use data to the terminal apparatus.

Summary of Invention Paragraph:

[0038] In the above arrangement, when the acquiring section acquires the screen data and the device data, the generating section generates the terminal-use data in accordance with the data. The terminal data is transmitted to the terminal apparatus via the network by the communication means. In this way, displayed on the terminal apparatus is the display-use screen in accordance with the screen data and the device data.

Summary of Invention Paragraph:

[0039] Another control system of the present invention is, in order to attain the above objects, is so arranged as to be provided with the control display apparatus including a recording section for storing therein screen data, which is data of the display-use screen, and a transmitting section for transmitting the screen data stored in the recording section in accordance with a request from a terminal apparatus; a communication section for acquiring, from the control display

apparatus, device data indicating a state of the device, the communication section being capable of communicating with the terminal apparatus via a network; an execution program recording section for storing therein an execution program for causing the terminal apparatus to perform an action of inquiring the communication section about the device data corresponding to the screen data transmitted, and an action of displaying the display-use screen on the terminal apparatus in accordance with a response to the inquiring; and a generating section for generating terminal-use data for displaying the display-use screen on a display surface of the terminal apparatus, in accordance with the thus acquired screen data and the device data, the communication section transmitting the execution program and the terminal-use data to the terminal apparatus so as to cause the terminal apparatus to perform the actions, and acquiring device data that is inquired about by the terminal, so as to transmit the device data.

Summary of Invention Paragraph:

[0040] In the above arrangement, when the terminal apparatus requests the transmission of the screen data, the transmitting section transmits the screen data stored in the recording section. Then, the generating section generates, in accordance with the screen data, the terminal-use data containing the program for executing the respective actions. The terminal-use data and the execution program (such as an applet) stored in the execution program recording section are transmitted to the terminal apparatus via the network by the communication section. Moreover, the communication section transmits the device data, which the communication section acquires from the control display apparatus, to the terminal apparatus, when the terminal apparatus inquires for the device data, by executing the execution program. The terminal apparatus that has received the device data, executes the execution program by using the terminal-use data, so as to display the display-use screen in such a manner that the state of the device is reflected on the display-use screen.

Summary of Invention Paragraph:

[0041] (4) A control system of the present invention, in order to attain the objects, is provided with a control display apparatus for displaying a state of a device on a display-use screen that has been generated in advance, and for giving a control instruction for the device via the display-use screen; a server apparatus including a server-end communication section for acquiring device data from the control display apparatus, and for transmitting the device data, the device data indicating the state of the device; a plurality of terminal apparatuses including a terminal-end recording section for storing screen data in a format suitable for display processing, the screen data being for the display-use screen, a display processing section for inquiring the server-end communication section about whether or not the server-end communication section has acquired the device data corresponding the screen data stored in the terminal-end recording section, and for displaying the display-use screen in accordance with the device data transmitted from the server-end communication section, and a terminal-end communication section for communicating with the server-end communication section via a local network so as to receive the inquiry from the display processing section and the device data as a reply for the inquiry.

Summary of Invention Paragraph:

[0042] In the above arrangement, in the terminal apparatus, the display processing section acquires the device data corresponding the screen data stored in the terminal-end storing section, by inquiring the server-end communication section, so as to display the display-use screen in accordance with the device data.

Summary of Invention Paragraph:

[0043] The control system is preferably arranged such that the server apparatus includes a server-end storing section for storing the screen data in a format suitable for display processing, and a communication relay section for relaying communication between the server-end communication section and a public network,

the server-end communication section acquiring the screen data stored in the server-end storing section and giving the screen data to the communication relay section, and the display processing section (a) inquires the server-end communication section, by relay communication via the relay section via the public network, about whether or not the server-end communication section has acquired the screen data stored in the server-end storing section and the device data corresponding thereto, and (b) displays the screen-use screen in accordance with (i) the screen data transmitted from the server-end communication section by the relay communication and (ii) the device data corresponding thereto, (c) causes the server-end communication section to perform the communication via the local network for acquiring the screen data stored in the terminal-end storing section, and (d) causes the sever-end communication section to perform the communication via the public network for acquiring the screen data stored in the server-end storing section.

Summary of Invention Paragraph:

[0044] With this arrangement, in the terminal apparatus, the display processing section acquires the screen data stored in the server-end storing section and the device data corresponding thereto by inquiring the server-end communication section by the relay communication via the relay section via the public network, so as to display the display-use screen in accordance with the screen data and the device data corresponding thereto. Moreover, because the display processing section acquires any one of the screen data in accordance with the instruction from a user, communication via the local network or that via the public network is automatically selected. Thus, the user can perform communication suitable for a receiver of that screen data, without paying special attention to the selecting the communication. Therefore, while a user does not notice it, it is possible to perform a communication suitable for an end that acquires the screen data.

Summary of Invention Paragraph:

[0045] (5) In order to attain the objects, a control system of the present invention, for accumulating data regarding a control apparatus to which an input apparatus and an output apparatus are connected, by communication, via a designated network in a communication protocol designated to the control apparatus, between the control apparatus and display-type control apparatuses, which display control states of the input and the output apparatus caused by the control apparatus, and which give a control instruction to the control apparatus, and by communication, via a common network in a common communication protocol, between a host computer provided ranking above the display-type control apparatus, and at least one of the display-type control apparatuses, wherein: the display-type control apparatus includes: a protocol converting section for converting the communication protocols used in both the networks from one to the other; and a delivery section for delivering to the host computer, a user program for displays a control states of the control apparatus, the user program being executed when a preset delivery condition is satisfied, respective change elements, which are corresponded to addresses of the input and the output apparatus in the user program, and which are changed in accordance with data of the control instruction and the output data resulted from the control instruction data, and the control instruction data and the output data corresponding to the change elements, and the host computer includes: an accumulating section for accumulating the user program, the change elements, and both the data, which are thus delivered, sequentially in time sequence and per the display-type control apparatus; a searching section for consecutively searching and displaying the user program, the change elements and both the data accumulated in the accumulating section; a converting section for converting, into an execution program executable for a terminal apparatus, the user program searched out by the searching section as requested by the terminal apparatus; and a communicating section for transmitting the execution programs, the change elements, and both the data to the terminal apparatus that executes the execution program, so as to change the change elements in the user program in accordance with both the data.

Summary of Invention Paragraph:

[0046] In the above arrangement, the output data from the control apparatus is transferred to the display-type control apparatus via the designated network. In the display-type control apparatus, the protocol converting section converts the communication protocol of the designated network into the communication protocol of the common network. Thereafter, the output data is transferred from the display-type control apparatus to the host computer connected via the common network.

Summary of Invention Paragraph:

[0047] Moreover, when a predetermined delivery condition (such as specific time, specific interval) is satisfied, the executed user program (for example, a screen displayed on the programmable display apparatus, and a ladder program of a PLC), the respective change elements of the user program (for example, a symbol on the screen, and a ladder symbol on the ladder program), the control instruction data, and the output data, which correspond to the change elements, are delivered to the host computer. Then, the executed user program, the change elements, the control instruction data, and the output data are accumulated sequentially in time sequence per display-type control apparatus, by the accumulating section in the host computer.

Summary of Invention Paragraph:

[0048] Moreover, because the searched out user program is continuously displayed, a status of the user program at a time the control apparatus was in action can be reproduced. Further, when the user program searched out by the host computer is converted into the execution program by the converting section, the converted execution program is transmitted to the terminal apparatus by the communication section, together with the change elements and both the data. In the terminal apparatus, when the execution program is executed, the change elements in the user program are changed in accordance with both the data. As a result, for example, states of changing the change elements are displayed on the screen.

Summary of Invention Paragraph:

[0049] (6) A recording medium of the present invention is also arranged to store therein a control communication program for causing a computer to execute respective section so as to realize the control server apparatus, the control terminal apparatus, and the control system by software. When the program is read out from the recording medium and executed, the computer acts as the control server apparatus, the control terminal apparatus, and the control system.

Brief Description of Drawings Paragraph:

[0051] FIG. 1 is a block diagram illustrating an arrangement of a control system according to a first embodiment of the present invention.

Brief Description of Drawings Paragraph:

[0052] FIG. 2 is an explanatory view showing a relationship between screen data and a screen to be displayed, where a switch of a programmable display apparatus of the control system is OFF.

Brief Description of Drawings Paragraph:

[0054] FIG. 4 is an explanatory view showing a data-structural example of a process instruction word for display, among the above-mentioned process instruction words.

Brief Description of Drawings Paragraph:

[0056] FIG. 6 is an explanatory view illustrating a relationship between the screen data and the screen to be displayed where the switch of the programmable device of the control system is ON.

Brief Description of Drawings Paragraph:

[0057] FIG. 7 is an explanatory view showing a main portion of an applet that is

generated by a compiler in the control system.

Brief Description of Drawings Paragraph:

[0058] FIG. 8 is a flow chart illustrating how the control system is operated.

Brief Description of Drawings Paragraph:

[0059] FIG. 9 is an explanatory view showing an example of a data transmission format that is used in a dedicated protocol in the control system.

Brief Description of Drawings Paragraph:

[0060] FIG. 10 is an explanatory view illustrating an example of a data transmission format that is used in a common protocol in the control system.

Brief Description of Drawings Paragraph:

[0061] FIG. 11 is an explanatory view showing an example of command conversion tables to look up for mutual conversion of the dedicated protocol and the common protocol by the programmable display apparatus.

Brief Description of Drawings Paragraph:

[0062] FIG. 12 is a block diagram illustrating an arrangement of another control system.

Brief Description of Drawings Paragraph:

[0063] FIG. 13 is an explanatory view showing an example of a display-use screen for setting conditions as to a network in the control system of FIG. 12.

Brief Description of Drawings Paragraph:

[0064] FIG. 14 is a flow chart for showing how the control system of FIG. 12 operates when normal displaying/controlling is carried out.

Brief Description of Drawings Paragraph:

[0065] FIG. 15 is a flow chart for illustrating how the control system of FIG. 12 operates when a control program is updated.

Brief Description of Drawings Paragraph:

[0066] FIG. 16 is a block diagram illustrating an arrangement of still another control system.

Brief Description of Drawings Paragraph:

[0067] FIG. 17 is an explanatory view showing an example of an XML file to deliver from an open server to a client apparatus, in the control system of FIG. 16.

Brief Description of Drawings Paragraph:

[0068] FIG. 18 is an explanatory view showing an example of an HTML file to deliver from an open server to a client apparatus, in the control system of FIG. 16.

Brief Description of Drawings Paragraph:

[0069] FIG. 19 is a block diagram showing a modification of the control system of FIG. 16.

Brief Description of Drawings Paragraph:

[0070] FIG. 20 is an explanatory view showing an example of an HTML file to deliver from an open server to a client apparatus, in the control system of FIG. 19.

Brief Description of Drawings Paragraph:

[0074] FIG. 24 is a block diagram showing an arrangement of a control system of another configuration.

Brief Description of Drawings Paragraph:

[0075] FIG. 25 is a flow chart showing how the control system of FIG. 24 operates.

Brief Description of Drawings Paragraph:

[0076] FIG. 26 is an explanatory view illustrating another display-use screen displayed on a programmable display apparatus or a client apparatus, in the control system of FIG. 24.

Brief Description of Drawings Paragraph:

[0077] FIG. 27 is an explanatory view showing a display-use screen based on a new XML file that is generated by editing each XML showing the display-use screen.

Brief Description of Drawings Paragraph:

[0078] FIG. 28 is a block diagram showing an arrangement of a control system, which is a modification of the control system of FIG. 24.

Brief Description of Drawings Paragraph:

[0079] FIG. 29 is a block diagram showing an arrangement of a control system, which is another modification of the control system of FIG. 24.

Brief Description of Drawings Paragraph:

[0080] FIG. 30 is a block diagram illustrating an arrangement of a control system, which is a modification of the control systems of FIGS. 24, 28 and 29.

Brief Description of Drawings Paragraph:

[0081] FIG. 31 is a block diagram showing an arrangement of a control system according to a second embodiment of the present invention.

Brief Description of Drawings Paragraph:

[0082] FIG. 32 is a flow chart illustrating a process procedure for making a screen data public by uploading the screen data from a programmable display apparatus in the control system of FIG. 31.

Brief Description of Drawings Paragraph:

[0083] FIG. 33 is a block diagram showing another arrangement of the control system according to the second embodiment of the present invention.

Brief Description of Drawings Paragraph:

[0084] FIG. 34 is a flow chart illustrating a process procedure for causing a client apparatus of the control system of FIG. 33 to display a screen that is to be displayed on a programmable display apparatus.

Brief Description of Drawings Paragraph:

[0085] FIG. 35 is a block diagram of an arrangement of a modification of the control system of FIG. 33.

Brief Description of Drawings Paragraph:

[0086] FIG. 36 is a flow chart illustrating a process procedure for causing a client apparatus of the control system of FIG. 35 to display a screen that is to be displayed on a programmable display apparatus.

Brief Description of Drawings Paragraph:

[0087] FIG. 37 is a block diagram showing an arrangement of another modification of the control system of FIG. 33.

Brief Description of Drawings Paragraph:

[0088] FIG. 38 is a block diagram illustrating an arrangement of a control system according to a third embodiment of the present invention.

Brief Description of Drawings Paragraph:

[0089] FIG. 39 is an explanatory view showing a communication protocol of a common network.

Brief Description of Drawings Paragraph:

[0090] FIG. 40 is an explanatory view illustrating a screen (reproduction screen), which is reproduced by searching and an operation screen for searching a database included in a personal computer in the control system.

Brief Description of Drawings Paragraph:

[0096] FIG. 44 is a block diagram showing a conventional control system.

Detail Description Paragraph:

[0100] A control system according to the present embodiment shown in FIG. 1 is a system that is especially suitable for use in controlling a target system that is controlled by a plurality of PLCs, which work in combination, for example, in case where the target system is an automatic assembling machine of a belt conveyer type.

Detail Description Paragraph:

[0101] The present control system is provided with programmable logic controllers (PLCs) 3, programmable display apparatuses (hereinafter, just referred to as display apparatuses) 5, a network 6, a control host computer (hereinafter, just referred to as a control computer) 7, and a client apparatus (terminal apparatus) 9.

Detail Description Paragraph:

[0102] The PLCs 3, which are control apparatuses for controlling respective devices 10 that compose target systems in accordance with a control program stored in advance, are connected with the display apparatuses 5 via serial cables 4. The PLCs 3 are provided with a CPU/power source module, an input unit, and an output unit. The CPU/power source module is provided with (a) a CPU section including a CPU and a memory, and (b) a power source section for supplying an electric power to each section of the PLCs 3. The CPU section controls the devices 10, which are control-object apparatuses (apparatuses to be controlled), in accordance with a control program. Specifically, the CPU section processes control data to be given to an output apparatus in accordance with a signal inputted via the input unit from an input apparatus, where the input apparatus and the output apparatus are the devices 10. The input unit and the output unit are component having an interface function to be connected with an input apparatus and an output apparatus, respectively. The input unit and the output unit exchange with the CPU section a digital signal or an analogue signal that is exchanged between those apparatuses.

Detail Description Paragraph:

[0103] As the input apparatuses, apparatuses such as sensors (temperature sensor, optical sensor), switches (push-button switch, limit switch, pressure switch and the like) are used. As the output apparatuses, actuators, relays, magnetic valves, and display apparatuses are used. Those input apparatuses and output apparatuses are positioned in each of target sections (where the apparatuses need be positioned) of various target systems such as manufacturing lines.

Detail Description Paragraph:

[0104] The display apparatuses 5 are operated by an operator in a vicinity of the target systems, in most cases. The display apparatuses 5 are connected with each other via the network 6. Moreover, a control computer 7 is connected to the network 6. On the other hand, the client apparatus 9 can be connected to the control computer 7 via the Internet 32. In most cases, the control computer 7 carries out supervising control, setting, and the like process as to the whole control system, from a remote location remote from the display apparatuses 5. Moreover, the target system, the display apparatuses 5, and the control computer 7 compose a local control system 31.

Detail Description Paragraph:

[0105] The display apparatuses 5 are provided with (a) a memory such as a RAM, a ROM, a flash ROM, a VRAM and the like, and (b) a processor such as a CPU. Those memory and processor control action of each section of the display apparatus 5. The display apparatuses 5 are display apparatuses that can control input and screen display in accordance with screen data determined by combining process instruction words (tag). The display apparatuses 5 are provided with a PLC-end communication processor 51 (dedicated protocol communication means), a network-end communication processor 52 (common protocol communication means), a protocol converter 53 (relay means), a screen data memory 54, and a display processor 55.

Detail Description Paragraph:

[0106] The PLC-end communication processor 51 is connected to the serial cable 4, while the network-end communication processor 52 is connected to the network 6. The protocol converter 53 relays communication between both the communication processors 51 and 52, while the screen data memory 54 stores the screen data. The display processor 55 carries out display processing in accordance with (a) the screen data, (b) operation by the operator on an operation input section 55a, such as a touch panel, (c) communication results, and the like. In addition, a bar code reader 55b or an ID sensor (not shown) and the like may be another input means.

Detail Description Paragraph:

[0107] In the present embodiment, the display processor 55 can switch over between a plurality of unit screens. Each unit screen is formed by arranging, on a base screen, for example, (a) a stationary figure B, such as a name plate, whose display content will not be changed, component figure J (J1), such as a switch, a lamp, or a meter, which is converted in terms of its display conditions such as shapes, colors, and turning-on-and-off conditions, as shown in FIG. 2.

Detail Description Paragraph:

[0108] On the other hand, the screen data for displaying the screen is, as shown in FIG. 3, composed by combining (a) a file number F of the base screen, (b) an event name N for specifying contents of operation that should be performed on the base screen, and (c) a process instruction word (tag) W including one or more of reference information R, which is referred to for each event to be carried out (carry-out event).

Detail Description Paragraph:

[0109] A process instruction word WL shown in FIG. 4 is specifying information for specifying a display component. The process instruction word WL is used, for example, when a component figure J that corresponds to contents of a predetermined device address is displayed on a predetermined screen region (display coordinate ranges). Included in the reference information R of the process instruction word WL are display coordinate ranges (X Y), device address A, and a file number FL to be referred to when displaying. Examples of the file number FL are a file of a figure representing ON and a file of a figure representing OFF, when the component figure J is a switch.

Detail Description Paragraph:

[0111] On the other hand, the file number F of the base screen extracts, in a predetermined time interval, the process instruction words WL (display tag), which are the base screen that is being displayed, from the screen data memory 54, and reads out contents of the device address A of each display tag WL from a memory 3a of the PLC 3, so that the display processor 55 of the display apparatus 5 displays, on the screen, the component figure J corresponding to the contents. For example, in FIG. 2, the display tag WL1 stored in the screen data memory 54 represents a display of a switch, and corresponds to an apparatus of the device address A1.

Detail Description Paragraph:

[0112] When the display tag WL1 is carried out, the display processor 55 judges that the switch is OFF, because the contents of the device address A1 is "0". Then,

the display processor 55 displays, in the display coordinate ranges (X.multidot.Y), a figure of the file FL1 that is corresponded to OFF, among the files stored in the memory 55a of the display processor 55. By doing this, the component figure J1 that represents the switch in the OFF state is displayed in the coordinate ranges (X.multidot.Y). As described above, the display processor 55 carries out the display tag WL1 in the screen data in the predetermined time interval, so that a state of device will be reflected in the screen on the display apparatus 5.

Detail Description Paragraph:

[0113] Moreover, upon reception of the input operation of the operator, such as pressing a touch panel (not shown), the display processor 55 reflects the input operation in the screen. In order to do this, the display processor 55 searches the screen data of the screen data memory 54 and searches out the process instruction word WT (input tag) that corresponds to the base screen that is being displayed, and that matches with the input operation. Then, in accordance with an input result, the display processor 55 changes the contents of the device address A indicated by the input tag WT.

Detail Description Paragraph:

[0114] For example, where the effective input coordinate ranges (X.multidot.Y) are set to be the same coordinate ranges as the component figure J1, and an input tag WT1 that changes the contents of the same device address A1 is included in the screen data, the input tag WT1 is found as a result of search performed by the display processor 55, when the operator presses the component figure J1 on the display-use screen shown in FIG. 2. In this case, the display processor 55 rewrites the contents of a device address A1 that corresponds to the input tag WT1, for example by giving instructions to the PLC-end communication processor 51 or the network-end communication processor 52.

Detail Description Paragraph:

[0115] Further, after the input operation, the contents of the device address A1 is changed to "1", when the display processor 55 processes the display tag WL1. By doing this, the display processor 55 displays a component figure J2 that corresponds to a file FL2 and represents ON, as shown in FIG. 6. Because of this, the display processor 55 can rewrite the contents of the device address in accordance with the input operation, and can update the screen display in accordance with the contents of the device address.

Detail Description Paragraph:

[0116] Note that the device address A is an address for specifying a device to be an object of control (a device to be controlled), and represents one region of a storing apparatus provided to the display apparatuses 5, the PLCs 3, the control computer 7 or the like, such as the memory 3a of each PLC 3. Moreover, the device may be a memory that stores data manually inputted from an input apparatus such as the operation input section 55a or the bar code reader 55b. Further, as described later, the contents of each address can be acquired and the contents can be changed, for example, via communication of the PLC-end communication processor 51 or the network-end communication processor 52 with the PLCs 3 or another display apparatuses 5. The acquisition/changing may be carried out by giving instructions on each time of the acquisition/changing of the contents of each address. Alternatively, it may be so arranged that the display apparatuses 5 is provided with a chase so that the acquisition/changing may be carried out synchronously to an entity of the device address A, by accessing to the chase when the acquisition/changing of the contents is carried out, and communicating in every predetermined interval or for each predetermined event.

Detail Description Paragraph:

[0117] The control computer 7 (control server) is provided with a display processor 71, a common protocol (interface) IF section 72 (display apparatus-end communication means) and a server section 73. The control computer 7, in most

cases, can display and control the state of the target systems, the PLCs 3, the display apparatuses 5 and the like, from a remote location that is remote from the display apparatuses 5. The display processor 71 performs supervising control of the whole control system, while the common protocol IF section 72 is connected with the network 6. The server section 73 responds to a request from the display processor 71 and the like, by communicating with each display apparatus 5 via the common protocol IF section 72 and the network 6.

Detail Description Paragraph:

[0118] Moreover, the control computer 7 is provided with a screen generating processor 74 for generating screen data of the display apparatuses 5, and a screen data memory 75 for storing the generated screen data. Screen data that regulate display/control action of the respective display apparatuses 5 are integrally generated (corrected) by the screen generating processor 74, then are delivered to the respective display apparatuses 5 via the server section 73, the common protocol IF section 72 and the network 6.

Detail Description Paragraph:

[0119] Here, the screen data is composed by combining the tags (process instruction word) that represent corresponding relationship between the region on the screen and the address of the device that corresponds to display and input on the region, as described above. The screen generating processor 74, for example, displays a pallet of tags, and prompts a user to select a tag and to place the desired tag on the screen. Moreover, the screen generating processor 74 displays thus placed tag on a specified coordinates. The screen generating processor 74 adjusts the coordinates of the tag in accordance with dragging and dropping by the user. Moreover, the screen generating processor 74 prompts the user to input a device address that relates to an input tag or a display tag.

Detail Description Paragraph:

[0120] By operating the screen generating processor 74 in accordance with this, the user can place the tag in the desired location on the screen and can generate the screen data simply by associating the tags and the addresses of the devices respectively. Because of this, the display and action of each display apparatus 5 can be more easily decided (changed), compared with a case where a display program of the display apparatus 5 is corrected. Therefore, a user of the control system (user of the control computer 7) can have the display and action of the display apparatus 5 adjusted according to actual conditions of the target system, level of skill of the operator of the display apparatus 5, or what the user likes.

Detail Description Paragraph:

[0121] The control computer 7 is further provided with a compiler 76 (converting means) and an open server section 77 (terminal-end communication means). The compiler 76 converts the screen data itself which the display apparatus 5 is using so as to displaying, or screen data having the same structure as the screen data, into an applet in the Java (Registered Trademark) language, which allows a virtual machine 91 of the client apparatus 9 to carry out an equivalent process. The open server section 77 delivers the applet to the client apparatus 9 via the Internet 32, and communicates with the applet that is carried out by the client apparatus 9.

Detail Description Paragraph:

[0123] Specifically, for example in case of the display tag, the method is a drawing method that is called out in a predetermined time interval so that the method requests data of a specific device address from the open server section 77, and carries out display that corresponds to a response. Moreover, in case of the input tag, the method is an input method that is called out when an input event occurs, and requests the open server section 77 to write, into a specific device address, data that corresponds to an input result.

Detail Description Paragraph:

[0126] In this manner, the compiler 76 can generate the applet to cause the client apparatus 9 to display the same screen as a screen displayed in case the display apparatus 5 displays the screen data. Moreover, the compiler 76 of the present embodiment stores the generated applet (HTML document) in a storing apparatus (not shown) in such a manner that the applet is associated with the screen data, because the generated applets are identical in contents, as long as the screen data is not altered. The open server section 77 reads out the identical screen data from the storing apparatus, upon request of the identical screen data. This improves a generating speed, compared with a case the compiling is carried out for every request.

Detail Description Paragraph:

[0127] Moreover, the open server section 77 distinguishes the screen data that the client apparatus 9 requests, for example in accordance with URI (Universal Resource Identifier) or the like, and sends the applet to the client apparatus 9 via CGI (Common Gateway Interface), BGI (Binary Gateway Interface), or the like. In addition, the open server section 77, upon receipt of instructions of obtaining/altering contents of the device address A, relays the instructions, and sends the instructions of obtaining/altering the contents to an entity of the device address, for example, the display apparatus 5 itself, or the PLC 3 connected with the display apparatus 5, similarly to the case where the display apparatus 5 communicates with other display apparatuses 5 or the PLC 3 so as to obtain/alter the content of the device address A.

Detail Description Paragraph:

[0128] Note that, the open server section 77 is also able to reduce its response time with respect to the applet, by caching the contents of the device address, as the display processor 55 does.

Detail Description Paragraph:

[0129] The client apparatus 9 is, in addition to the virtual machine 91, provided with a browser 92 that is realized by a general-purpose browser software and the like. The browser 92 causes the virtual machine 91 to execute the applet that the browser 92 receives through communication with an apparatus connected with the Internet 32. Moreover, the browser 92 can receives and looks over a document such as the HTML document, from the server apparatus via HTTP (Hyper Text Transfer Protocol), for example.

Detail Description Paragraph:

[0130] The above-mentioned control system operates in a procedure of a flow chart shown in FIG. 8. To begin with, a user of the control system operates the previously-discussed screen generating processor 74 so as to generate/modify the screen data according to how the target system actually is, how an operator of the display apparatus 5 is skilled, or as the user prefers (S1). Further, the generated screen data is transmitted to the display apparatus 5 after the screen data is checked as to whether it operates normally, for example by simulation or connection test (S2). Then, the display apparatus 5 starts displaying in accordance with the screen data (S3).

Detail Description Paragraph:

[0131] Here, a most suitable screen cannot be defined to a particular screen, because what is the most suitable screen depends on factors such as the preference and skill of a user. Therefore, the screen is frequently converted comparatively. However, the present embodiment can smoothly deal with those requests, because, as described above, in the present embodiment, the user of the control system (the control computer 7) can generates the screen data by combining the tags. Therefore, the screen can be most suitable all the time. Moreover, because the management is carried out integrally by the control computer 7, the screen data is more easily managed, compared with a case in which the management is carried out in many places

at the same time.

Detail Description Paragraph:

[0133] While the control system is operated, the browser 92 accesses to the open server section 77, via the Internet 32, so as to instruct the open server section 77 to display a screen of a display apparatus 5 (S5). In response to this, the open server section 77 carries out authentication as to whether the display/control by using the screen is authorized or not for the client apparatus 9, so that the open server section 77 rejects an access from an unauthorized client apparatus 9 (S6). Here, checked is, for example, whether or not an identification number and a password received from the client apparatus 9 have a predetermined combination.

Detail Description Paragraph:

[0135] On the other hand, at S8, the browser 92 extracts an applet element (a portion from "<APPLET>" to "</APPLET>") from the received HTML document, so as to cause the virtual machine 91 to execute the applet. In this manner, the virtual machine 91 carries out the same display/control as the display apparatus 5 does, via communication with the open server section 77.

Detail Description Paragraph:

[0136] Specifically, at a predetermined time interval, the virtual machine 91 executes a drawing method of instance in accordance with each display tag in the applet. As a result, the virtual machine 91 makes an inquiry to the open server section 77 as to the contents of the device address A. Meanwhile, the open server section 77 instructs the server section 73 to read out the contents of the device address A. The server section 73, as described later, obtains the contents of the device address A, then transmits the contents to the open server section 77, similarly to the case where the display processor 71 reads out the contents of each device address. Further, when the contents of the device address A are transmitted from the open server section 77 to the virtual machine 91 via the Internet 32, the drawing method updates the display of display region (X.multidot.Y) in accordance with the contents of the device address A.

Detail Description Paragraph:

[0137] Here, the applet is a result of compiling of the screen data. Each instance of the applet is set so as to refer to the same device address as a corresponding tag in the screen data. Moreover, each instance is generated so as to display the same screen as the tag, provided that the contents of the device address are same. Therefore, when the applet is executed, the part figure J1 (J2) that indicates the state of the device is displayed on the display-use screen of the client apparatus 9, as in FIGS. 2 and 6.

Detail Description Paragraph:

[0138] Note that action of switching unit screens is also realized as an input tag on the screen data of the present embodiment. The input tag is associated with, as a device address, a region in which data indicating a unit screen currently displayed, among the display regions in the display apparatus 5. Therefore, when the applet in which the screen data of a display apparatus 5 is compiled is executed in the client apparatus 9, the client apparatus 9 and the display apparatus 5 display the same unit screen all the time.

Detail Description Paragraph:

[0140] On the other hand, upon receipt of a request of writing from the virtual machine 91, the open server section 77 transmits the request to the server section 73. Further, the server section 73 rewrites the contents of the device address A, similarly to the case where the display processor 71 controls the device. As a result, the client apparatus 9 has the display-use screen that reflects on a result of the action as the display apparatus 5 does, at a time the drawing method is carried out after the writing.

Detail Description Paragraph:

[0142] As described above, in the control system of the present embodiment, the compiler 76 compiles the screen data, and generates the applet that can be executed on the virtual machine 91 of the client apparatus 9, and then the open server section 77 transmits the applet via the Internet 32. With this arrangement, the client apparatus 9 can display the screen that is identical with the screen to be displayed on the display apparatus 5, and control the PLC 3 and the display apparatus 5 by performing the same action as the display apparatus 5, even in a case where no program for supervising and controlling is pre-installed in the client apparatus 9, or in a case where the client apparatus 9 is in a remote location.

Detail Description Paragraph:

[0143] Moreover, the control computer 7 converts the screen data into the applet and makes the applet public. Because of this, a new screen data for use in the remote location is not necessary for the user of the control system. Thereby, significantly saved is labor for generating the screen. Further, when no screen data for the remote location is specially generated, the screen in the remote location and the screen on the display apparatus 5 are maintained to be identical all the time. Thereby, labor for management is significantly reduced, compared with a case the screen data for the both are separately generated and controlled to be identical with each other all the time.

Detail Description Paragraph:

[0144] Note that the present embodiment is explained referring to the example where the applet is generated that causes the client apparatus 9 to perform (a) the action of transmitting the inquiries and the instructions of converting in the same manner as the display apparatuses 5 do, and (b) the action of displaying in accordance with the response, and the control computer 7 relays the transmission of the contents of the device address. But the present invention is not limited to this.

Detail Description Paragraph:

[0145] For example, the control computer 7 may communicate with the display apparatus 5 so as to generate a file in the bit map format or in the JPEG format, which has identical contents to that of the screen display of the display apparatus 5, and to transmit the file to the client apparatus 9. The control computer 7 receives the data representing the screen of the display apparatus 5, and converts the data in terms of the format so that the data has a format in which the client apparatus 9 can display the data. Thereafter, the control computer 7 transmits the data to the client apparatus 9. In this way, it is not necessary to pre-install in the client apparatus 9 the program for the displaying and controlling of each display apparatus 5. Thereby, labor, time, and cost for installing are saved.

Detail Description Paragraph:

[0147] On the contrary, in the present embodiment the control computer 7 (a) distributes the applet for causing the client apparatus 9 to ask the inquiry, to give instructions of converting, and to display, and (b) relays the transmission of the contents of the device address. This significantly reduces an amount of data transmitted, and greatly improves the response speed of the client apparatus 9. Moreover, it is possible to further improve the response speed, because the client apparatus 9 end can deal with a user interface such as moving a cursor.

Detail Description Paragraph:

[0149] However, it is possible to execute the applet even if a machine language that an operation system (OS) and a CPU of the client apparatus 9 can execute is different, provided that the client apparatus 9 is provided with the virtual machine 91, where the control computer 7 transmits the applet so that the virtual machine 91 interprets the applet so as to display and control. Therefore, it is possible to perform the display/control at a greater number of the client

apparatuses 9, in the same manner as the display apparatuses 5, without increasing varieties of the applets to be generated by the control computer 7.

Detail Description Paragraph:

[0151] In addition, the communication via the Internet 32 allows the user of the client apparatus 9 to supervise and control without hindrance, as he uses the display apparatus 5, even if (a) the client apparatus 9 and (b) the system being composed of the control computer 7, the display apparatuses 5, and the PLCs 3 are located respectively in different countries. As a result, the user of the client apparatus 9 can be accurately informed of the state of the system, and give appropriate advice to an operator of the system, thereby support the operator, even if he is in a country other than the country in which the system is located. Therefore, it is not necessary to have a large number of support personals in vicinity of the system, thus significantly reducing labor for supporting.

Detail Description Paragraph:

[0152] By the way, in the present embodiment, the control computer 7 communicates with the display apparatus 5 in order that the open server section 77 of the control computer 7 obtains/converts the contents of the address of the device. But, the present invention is not limited to this. Similarly to the conventional system shown in FIG. 44, the control computer 7 may directly communicate with the PLC 3 so as to obtain/convert the contents of the address of the device.

Detail Description Paragraph:

[0153] However, in this case, for communicating with the PLC 3, the control computer 7 needs to communicate in a dedicated protocol specific to the type of the PLC 3. Because of this, it is necessary to have labor for generating a communication program for the control computer 7.

Detail Description Paragraph:

[0154] In the present embodiment, on the contrary, the protocol is converted by the display apparatuses 5, which are requisite to the control system, and whose calculating ability and memory capacity are not fully used compared with the PLCs 3. This allows the computer 7 to communicate in the common protocol, regardless of the types of the PLCs 3. Thus, it is possible to significantly reduce the labor for generating the communication program. Note that the display apparatuses 5 need to communicate in the dedicated protocol for communicating with the PLCs 3, even if the display apparatuses 5 are connected as shown in FIG. 44. Therefore, even if the display apparatuses 5 are provided between the control computer 7 and the PLCs 3, the labor for generating the communication protocol for the display apparatuses 5 will not be increased.

Detail Description Paragraph:

[0155] Specifically, in the control system of the present embodiment, a protocol (the common protocol) for transmission in the network 6 is specified so that data strings 61 (See FIG. 10) to be transmitted in the network 6 in displaying/controlling are identical among the PLCs 3 of different types, when the contents of the display or the contents of the control is identical, regardless of the types of the PLCs 3. Moreover, the display apparatus 5 that is provided in a central position in the communication inter-converts the common protocol and the dedicated protocols that are respectively specific to the types of the PLC 3, so that that display apparatus 5 relays the communication between (a) the PLC 3 to which that display apparatus 5 is connected, and (b) the control computer 7 or another display apparatus 5. In this manner, the control computer 7 and each display apparatus 5 can communicate with each other in the common protocol even if different dedicated protocols are used between the PLCs 3 that are respectively connected to the display apparatuses 5.

Detail Description Paragraph:

[0156] The target system is provided with a control-object apparatus, for example,

a valve or a motor, which operates in accordance with instructions, or devices 10, which may be a flow sensor or a temperature sensor, which detects a state of respective components in the target system. On the other hand, the PLCs 3 respectively communicate with the devices 10 so as to control the respective devices 10 in accordance with the control program stored in advance. The control program is transmitted to each PLC 3, for example by being transmitted from the control computer 7 via the display apparatus 5.

Detail Description Paragraph:

[0157] Here, because the PLCs 3 have been developed from the sequencer that uses a relay, in most cases, different control programs are used by the PLCs 3 of different manufacturers, and different product types for example, so that each type of PLCs 3 uses not only its own control program, but also its own dedicated protocol. Therefore, the PLC 3, which is connected with the display apparatus 5 via the serial cable 4, communicates with the display apparatus 5 in the communication protocol in which the PLC 3 can communicate.

Detail Description Paragraph:

[0158] In the dedicated protocol, when read-out of data is instructed, as schematically shown in FIG. 9, transmitted is a data string 41, which includes a control code (ESC) for indicating that a code transmitted next is a command, a command code (RD) for instructing the PLC 3 to read out the data, a read-out starting address (X0001), a read-out size (5) and a control code (RET) for indicating an end of the transmission. However, in most cases, the respective PLCs 3 are different from each other in terms of (a) sequences for the address, size, and the like, (b) the control code itself, (c) a representation format for representing the address or the code (for example, a type of code for representing a bit width or a character for indicating the numeral value), or (d) commands systems, in which the command code is included.

Detail Description Paragraph:

[0159] On the other hand, the network 6 of the present embodiment is, for example, a LAN (Local Area Network) such as the Ethernet (Trademark: Xerox Corp.). In the network 6, the respective display apparatuses 5 and the control computer 7 communicate with each other in the TCP/IP protocol. Because of this, a communication apparatus capable of communicating in the TCP/IP can freely participate in the network 6 without disturbing transmission of data between other communication apparatuses, for example, even if a control host computer (not shown) or the like used by a developer of the control system is in a location different from where an operating company of the control system, and is connected from the location via the telephone line.

Detail Description Paragraph:

[0160] Note that, in the TCP/IP protocol, each module, such as TCP modules or IP modules, attaches a header for use in transmission, to the data string 61 to be transmitted. However, in the present specification, wordings "the data string 61 to be transmitted via the network 6" are used to mean "data string, which a upper layer requests a TCP module to transmit, and which the TCP module of reception end to send to the upper layer".

Detail Description Paragraph:

[0161] In the present embodiment, in the common protocol, which is specified for use in transmission in the network 6, the data string 61 includes (a) identification data 62, which is for identification, for example, as to whether the data string 61 is the data for displaying/controlling or the control program, and (b) a data body 63, as shown in FIG. 10. Further, as the data for displaying/controlling, a data body 63r used in sending to the PLC 3, for example, a command for instructing data read-out includes (a) a common code 64 for representing contents of the command, and (b) a read-out starting address 65a and a read-out size 65b, which are relevant information 65 to be attached to the common

code 64. Moreover, the data body 63w for instructing data write-in includes a write-in start address 65c and a write-in data 65d, as relevant information 65.

Detail Description Paragraph:

[0162] In the common code 64, regardless of the command codes of the PLCs 3, a universal code is used for commands having the same contents, among the commands understandable for each of PLC 3. Moreover, also unified regardless of the types of the PLCs 3 are order and format of transmission of data of relevant information 65, such as reading-start address 65a and reading size 65b. This makes it possible to specify one command for one meaning in the common protocol, regardless of which PLC3 is connected to the display apparatus 5. Further the data strings 61 to be transmitted through the network 6 when displaying/controlling have the same data string, regardless of the types of the PLCs 3.

Detail Description Paragraph:

[0163] Here, the display apparatuses 5, as described above, are provided with the PLC-end communication processor 51, the network-end communication processor 52, and the protocol converter 53, which are shown in FIG. 1. In case the dedicated protocol and the common protocol are different from each other, the protocol converter 53 inter-converts the protocols from one to the other. In this way, the display apparatus 5 can display on its screen the states of the PLC 3 connected thereto or that of the PLC 3 connected to the other display apparatus 5, while relaying communication in the dedicated protocol and communication in the common protocol according to need. Moreover, the display apparatus 5 outputs instructions for the PLC 3 in accordance with operation by an operator.

Detail Description Paragraph:

[0164] Note that the conversion of protocol is carried out, for example, by a method disclosed in International Patent Publication WO NO. 99/56186 (Published on Nov. 4, 1999).

Detail Description Paragraph:

[0165] The protocol converter 53 stores, as protocol information for inter-converting the protocols, (a) a data transmission format FMT for representing a format of the data string 41 to be transmitted in the dedicated protocol, and (b) a command code in the designated protocol, (c) a command conversion table TBL for representing a corresponding relationship between a command code in the dedicated protocol and the command code.

Detail Description Paragraph:

[0167] Moreover, the command conversion table TBL, as shown in FIG. 11, shows correspondence between the command code 64 and the command code of the PLCs 3 connected to the serial cables 4. The protocol converter 53 converts one code into another code.

Detail Description Paragraph:

[0168] Before the display apparatuses 5 and PLCs 3 transmit the data regarding the display and control, combination between the data transmission format FMT and the command conversion table TBL is set in accordance with the communication protocol of the PLCs 3, so that the protocol information is changed over when a PLC 3 using a different communication protocol is connected. For example, if a PLC 3 of type A is replaced with a PLC 3 of type B, a command conversion table TBLa is changed over to a command conversion table TBLb, which are shown in FIG. 11.

Detail Description Paragraph:

[0169] Note that, the communication protocol may be selected, for example, by user's operation of the computer 7 or the display apparatuses 5. Further, the display apparatuses 5 themselves may send, to the PLCs 3, a command that can specify the communication protocol of the PLCs 3, while sequentially selecting communication protocols that can be sent out, and may identify the communication

protocol automatically in accordance with a response code from the PLCs 3. Moreover, the display apparatus 5 may be so adopted as to store the protocol information, with respect to all the communication protocols used by PLCs 3 that can be connected to the display apparatuses 5, or may be so adopted that the display apparatuses 5 stores only a communication protocol of PLCs 3 currently connected thereto, and downloads in accordance with need. The downloading may be carried out in various methods, such as from the control computer 7 or using a recording medium.

Detail Description Paragraph:

[0170] As described above, while the control system is operating, the protocol converter 53 generates the data string 41 to be sent and received to/from the PLCs 3. In this way, the display apparatuses 5 can send and receive data to/from the PLCs 3, without asking where inputted data come from, and can respond to the replacement of the PLCs 3, without stopping the control system.

Detail Description Paragraph:

[0171] Here, the display apparatuses 5 are requisite elements to the control system. For displaying a high-resolution screen, the display apparatuses 5 recently have a recording capacity of, for example, a few M bits (in general, PLCs have a few tens bits), and an operation speed that is fast enough for such displaying. Therefore, the display apparatuses 5 can perform the protocol conversion with a sufficient reserve capacity, compared with a PLC 3 suitable for the I/O control.

Detail Description Paragraph:

[0172] Moreover, because there is no PLC 3 between the display apparatuses 5 and the control computer 7, the PLCs 3 can concentrate in controlling the target systems. Therefore, by having the conventional arrangement shown in FIG. 44, that is, by connecting the respective PLCs 503 with each other and connecting the respective PLCs 503 with the display apparatuses 505, it is possible to reduce the recording capacity and operation ability of the PLCs, compared with the arrangement in which the PLCs 503 process most of communication within the control system 501.

Detail Description Paragraph:

[0173] Note that, one of examples of processes in which a large amount of communication is processed is a process in which the screen data is downloaded from the control computer 7 to the display apparatus 5 when the product to be manufactured by the target system is going to be changed to another product. However, in the local control system 31 of the present embodiment, the screen data does not pass through the PLCs 3. Therefore, normal action of the PLCs 3 is maintained because the PLCs 3 do not have a large workload even when the screen data is downloaded.

Detail Description Paragraph:

[0174] Moreover, the respective display apparatuses 5 and the control computer 7 communicate with each other in the common protocol, regardless of the types of the PLCs 3. Therefore, this allows plural types of PLCs 3 to be in the same local control system 31, thus giving more varieties in selecting the types. Further, the common communication protocol is used in the network 6 in the local control system 31. Therefore, it is possible to freely utilize apparatuses, such as a hub, a bridge, and a router, which are to be connected to the network 6. Further, this improves a degree of freedom as to the positional arrangements of those apparatuses and the PLCs 3. In addition, it is possible to reduce a manufacturing cost of the local control system 31 as a whole, because it is not necessary to have a converter 510 (see FIG. 44) of the conventional control system.

Detail Description Paragraph:

[0175] In addition, in the present embodiment, where the display apparatus 5 converts the protocols, apparatuses such as the display apparatus 5 and the control computer 7, which are connected to the network 6, can communicate with each other

in the common protocol, regardless of the types of the PLCs 3. Therefore, the server section 73 and the common protocol IF section 72 of the control computer 7 can communicate only in the common protocol with the respective display apparatuses 5 and the PLCs 3 via the display apparatuses 5.

Detail Description Paragraph:

[0176] More specifically, the server section 73 identifies, based on the device address, a recipient (IP address) that will receive the data that may be a write-in request, a read-out request, or the like. In case the recipient is the display apparatus 5, the server section 73 transmits the data to the IP address in the common protocol. On the other hand, if it is judged that the device address is the PLC 3, the server section 73 transmits the data to the display apparatus 5 of the IP address that is connected to the PLC 3.

Detail Description Paragraph:

[0177] Note that, association between the respective display apparatuses 5 and the respective IP addresses is determined when the display apparatuses 5 are connected to the network 6, for example, via designation by the user of the control computer 7, or via allotting a vacant IP address by the control computer 7. The association is stored in the storing region (not shown) of the server section 73. Moreover, for example in case those addresses are determined for each display apparatus 5, the device address of the respective display apparatuses 5 and the device addresses of the PLCs 3 to be connected with the display apparatuses 5 are determined by the control computer 7 by reading out a correspondence table stored in the display apparatus 5, or by distributing a correspondence table to the display apparatuses 5 if the addresses can be set by the control computer 7. Therefore, the server section 73 can, by looking up to the correspondence table of the device addresses and the correspondence table for the IP addresses, determine the IP address, which will be a recipient for a reading-out request or a writing-in request.

Detail Description Paragraph:

[0178] Here, each section in the display apparatus 5, the control computer 7 and the client apparatus 9 is a function block that is realized by such an arrangement where processing means such as a CPU executes a program stored in storing means such as a ROM or a RAM, so as to control input/output means such as a touch panel or a liquid crystal display apparatus, or a communication circuit such as an interface circuit. Therefore, it is possible to realize the display apparatus 5, the control computer 7 and the client apparatus 9, simply by a computer that has those means, the computer reading a recording medium (for example, a CD-ROM) that stores therein the program, and executing the program. Especially, it is possible to realize the virtual machine 91 and the browser 92 of the client apparatus 9 by using general-purpose browser software, which is pre-installed on most of computers. Those computers can be operated as the client apparatuses 9, without installing a special program.

Detail Description Paragraph:

[0180] Next, another configuration of the control system is explained.

Detail Description Paragraph:

[0181] In a local control system 31 of the present control system shown in FIG. 12, display apparatuses 5 have almost a similar arrangement as the display apparatuses 5 shown in FIG. 1. The display apparatus 5 of the present control system is provided with (a) a serial interface 56 that is provided between a serial cable 4 and a PLC-end communication processor 51 (dedicated protocol communication means), and (b) a network interface 57 that is provided between a network 6 and a network-end communication processor 52 (common protocol communication means and relay means). Although, both the interfaces 56 and 57 are not mentioned in the explanation on the control system of FIG. 1, the display apparatus 5 in the control system of FIG. 1 is also provided with both the interfaces 56 and 57.

Detail Description Paragraph:

[0182] Moreover, a display processor 55 of the display apparatus 5 instructs the network-end communication processor 52 so as to output, to another display apparatus 5, a data reading/writing command (command for reading and writing data) for a device 10 connected to the another display apparatus 5, when the display processor 55 displays/controls a state of the device 10. The data reading/writing command is specified in a common protocol. This allows the display processor 55 to communicate with the PLC 3 connected with the another display apparatus 5, without knowing a type of the PLC 3.

Detail Description Paragraph:

[0183] On the other hand, the PLC-end communication processor 51 communicates with the PLC 3 in a dedicated protocol that is specific to the PLC 3. In accordance with requests from a protocol converter 53 and the display processor 55, the PLC-end communication processor 51 outputs, to the PLC 3, the data reading/writing command and a control program that is outputted by the PLC-end communication processor 51. In case the PLC-end communication processor 51 receives from each of sections 51, 53, and 55 instructions to communicate with the PLC 3, the PLC-end communication processor 51, for example, stores the instructions temporarily, then processes the instructions one by one, so as to output commands and control programs requested by the respective instructions to communicate.

Detail Description Paragraph:

[0184] The network-end communication processor 52 sends and receives data string 61 to/from another display apparatus 5 and the control computer 7. Moreover, the network-end communication processor 52 identifies usage of a data body 63 (for what purpose the data body 63 is used), in accordance with identification data 62 in the thus received data string 61. In case the data body 63 is data for displaying/controlling, the network-end communication processor 52 gives the protocol converter 53 the data body 63. Moreover, in case the data body 63 is a control program, the network-end communication processor 52 gives the PLC-end communication processor 51 the data body 63, so that the PLC-end communication processor will send the control program to the PLC 3. Further, in case the data body 63 is screen data that represents a background screen of the display apparatus 5 or a location of a figure element corresponding to the device 10, the network-end communication processor 52 gives the data body 63 to the display processor 55 so as to update the screen data. On the contrary to this, when the network-end communication processor 52 receives the data body 63 from the protocol converter 53, the PLC-end communication processor 51 or the display processor 55, the network-end communication processor 52 attaches the identification data 62 to the data body 63, and sends the data body 63 to another display apparatus 5 or the control computer 7.

Detail Description Paragraph:

[0185] The protocol converter 53 generates the previously discussed data string 41 (see FIG. 9) that the protocol converter 53 sends and receives to/from the PLC 3 on real time while the local control system 31 is operating.

Detail Description Paragraph:

[0186] The control computer 7 further is provided with a user processor 78 and a setting section 79. The user processor 78 instructs a server section 72 so as to carries out processes such as a process of displaying/controlling a state of each devices 10 and a process of accumulating.

Detail Description Paragraph:

[0187] The setting section 79 performs setting of the whole local control system 31, for example, setting a station name and IP address of each display apparatus 5. Specifically, the setting section 79 manages, for example as shown in FIG. 13, (a) the station name and IP address of each display apparatus 5, (b) a maker, type, and version of the PLC 3 connected, and (c) the devices 10 connected respectively to

the PLCs 3, (d) and the like.

Detail Description Paragraph:

[0188] Lists of stations participating the network may be set by an administrating personnel of the local control system 31 using the input means (such as a keyboard) of the control computer 7. Alternatively, for example, the list of the stations participating the network may be automatically generated by the setting section 70 in accordance with status information, which indicates IP address of the display apparatuses 5 and PLCs 3 connected thereto. The status information is transmitted from the respective display apparatuses 5, in response to a node searching signal, which the setting section 79 instruct the server section 72 to transmit to the network 6.

Detail Description Paragraph:

[0189] Here, as described above, in the present local control system 31, the data string 61 transmitted through the network 6 by the display apparatus 5 having the protocol converter 53 is same, as long as the data string 61 represents the same display contents/control contents, regardless of the types of the PLCs 3. Because of this, even if the types of the PLCs 3 are different, the user processor 78 of the control computer 7 gives instructions to the server section 72 in the same procedure, so as to instruct the PLC 3 to control. Thereby, the user processor 78 can receive the data from the PLC 3. Therefore, what is required is to provide only a display apparatus 5 that must communicate with the PLC 3 with a program for communicating in the dedicated program. Moreover, even if a PLC 3 that communicate in a new communication protocol is developed, only the display apparatus 5 must deal with that PLC 3. As a result, it is possible to reduce labor for manufacturing and maintenance management of the local control system 31, compare with the control system of FIG. 44.

Detail Description Paragraph:

[0190] The client apparatus 9 (control terminal apparatus) is provided with an Internet communication processor 93 (wide area network communication means), a control program generating section 94 (control protocol generating means), and a serial port emulator (hereinafter, referred to as an SPE) 95 (serial port simulating means). The Internet communication processor 93 can be connected to the control computer 7 via the Internet 32. The client apparatus 9 of FIG. 1 is also provided with the Internet communication processor 93. The control program generating section 94 generates or modifies the control program of the PLC 3, and outputs the control program in a format in which the control program can be outputted from the serial port. The SPE 95 receives the control program instead of the serial port, and instructs the Internet communication processor 93 to transmit instruction data that indicate the control program itself and a PLC 3 of a destination.

Detail Description Paragraph:

[0191] On the other hand, the control computer 7 is provided with an Internet communication processor 80 that can be connected with the Internet communication processor 93 of the client apparatus 9 via the Internet 32 (wide area network). The Internet communication processor 80 specifies the PLC 3 of the destination, in accordance with the received instruction data, and instructs the server section 72 to transmit, to the display apparatus 5 connected to the PLC 3, the control program in the common protocol. In this way, the client apparatus 9 updates the control program of the PLC 3, from an arbitrary position that can be connected to the Internet 32.

Detail Description Paragraph:

[0192] Here, in order to realize the control program generating section 94, the present control system can utilize control program generating software that is used in an apparatus, such as the control host computer 507 shown in FIG. 44, directly connected via the serial port, because the SPE 95 is provided to the present

control system. In this way, for example, mnemonic, ladder circuit diagram, flow chart, or sequential function chart (SFC) can be used to write a control program, without developing new control program generating software for each type of the PLCs 3. Moreover, the control program generating section 94, which is presumed to be directly connected with the PLC 3, outputs the control program as data string to be outputted to the serial port.

Detail Description Paragraph:

[0193] On the other hand, the SPE 95 can set, in advance, (a) the control computer 7 of the local control system 31 having the PLC 3, and (b) the display apparatus 5 to which the PLC 3 is connected, in order to specify the PLC 3 of the destination. In addition, in case the display apparatus 5 is connected with more than one PLC 3, also set is which of the more than one PLC 3 of the destination.

Detail Description Paragraph:

[0194] Specifically, the SPE 95 can set the control computer 7 to which the Internet communication processor 93 is connected, for example by showing in advance a list of the local control system 31 that are permitted to update the control program of the PLCs 3, for promoting a user to select. Note that data to specify the control computer 7, such as addresses and domain names on the Internet 32, is stored in advance.

Detail Description Paragraph:

[0195] Moreover, the SPE 95 lets the user to specify the display apparatus 5, for example by displaying information with which the display apparatus 5 can be specified, among information displayed on a list of network participating stations shown in FIG. 5, in other words, by displaying a box in which an IP address or a station name is inputted or selected. Especially, the SPE 95 can automatically display choices by communicating with the control computer 7 in advance so as to look up memory contents of the setting section 79. This allows the user of the SPE 95 to designate the recipient in the same way as he specifies the display apparatus 5 by using the setting section 79 of the control computer 7.

Detail Description Paragraph:

[0196] Furthermore, when the SPE 95 receives, from the control program generating section 94, the data string for indicating the control program for the PLCs 3, the SPE 95 instructs the Internet communication processor 93 to transmit, via the Internet 32 to a control computer 7 specified by the setting set in advance, instruction data including (a) an identifier that indicates the display apparatus 5 and the PLCs 3, and (b) the data string indicating the control program.

Detail Description Paragraph:

[0200] With the above arrangement, at S11 (see FIG. 14), as to the respective display apparatuses 5 subscribed in the network, the setting section 79 sets IP addresses, station names, and the PLCs 3 connected to the respective display apparatuses 5 as network setting, prior to normal processes for displaying/controlling. Here, in case the protocol converting section 53 of the display apparatus 5 do not have the protocol information of the PLC 3 currently connected to the display apparatus 5, the protocol information may be downloaded from the setting section 79 to the protocol converting section 53. In this case, transmitted as the data string 61 shown in FIG. 9 are the data main body 63 indicating the contents of the program information, and the identification data 62 indicating the data string 61 is the protocol information. The data main body 63 is handed down to the protocol converting section 53 by the network-end communication processor 52.

Detail Description Paragraph:

[0201] In case the control computer 7 instructs the PLC 3 to control, as an example of normal processes, the user processor 78 instructs the server section 73 to transmit an data writing command to the PLC 3 in the common protocol shown in FIG.

9 (S12). The server section 73 refers to the network setting of S11 so as to obtain the IP address of the display apparatus to which that PLC 3 is connected, and transmits to the IP address the data string 61 that indicated the data writing command (S13).

Detail Description Paragraph:

[0202] On the other hand, in the display apparatus 5, the network-end communication processor 52 judges that the data string 61 is data for displaying/controlling, based on the identification data 62 of that data string 61, so that the network-end communication processor 52 hands down the data body 63 to the protocol converting section 53 for protocol conversion (S14). The protocol converting section 53 extracts the common code 64 and the relevant information 65 out of the data main body 63 in the common protocol, and selects, by looking up to the command conversion table TBL shown in FIG. 11, a command code that is recognizable to the PLC 3 and corresponds to the command code 64. Moreover, if necessary, a transcription of the relevant information 65 is converted to an expression that is recognizable to the PLC 3.

Detail Description Paragraph:

[0203] As a result of those, determined are the command code to be transmitted to the PLC 3, data contents, a size and address of the data, and the like. In response to this, the protocol converting section 53 generates the data string 41 to be transmitted to the PLC 3 by referring to the data transmission format FMT, and instructs the PLC-end communication processor 51 to transmit the data string 41.

Detail Description Paragraph:

[0204] Furthermore, the PLC-end communication processor 51 refers to a transmission request from the protocol converting 53 and transmission requests from other sections, such as a transmission request of the data string 41 from the display processor 55 and transmission request of the control program from the network-end communication processor 52, so as to transmit to the serial cable 4 the data strings 41 indicated respectively by those (S15). On the other hand, upon receipt of the data writing command in their designated protocol, the PLCs 3 control the states of the devices 10 in accordance with the command (S16).

Detail Description Paragraph:

[0205] Note that the above procedure is explained referring to the case of the data writing command as an example. However, the protocol converting section 53 also performs the protocol conversion in case of the data reading command. Moreover, the data transmission from the PLCs 3 to the control computer 7 is carried out in an inverse procedure with respect to the above procedure. Here, the protocol converting section 53, upon the receipt of the data string 41 from the PLC 3, applies the data string 41 to the data transmission format FMT, so as to extract the command, the data contents, the size and address of the data and the like that are indicated by the data string 41, generates the data body 63 in the common protocol, and output the data main body 63 to the network-end communication processor 52. In this way, the user processor 78 can receives, from the PLC 3, a data string in the common protocol, regardless of the type of the PLC 3.

Detail Description Paragraph:

[0206] On the other hand, when updating the control program, a process shown in FIG. 15 is carried out. Namely, the SPE 95 of the client apparatus 9 sets the recipient of the control program, prior to the updating of the control program (S21). The recipient, which is, as described above, combination in which the PLC 3 is paired with station names and IP addresses of the control computer 7 and the display apparatus 5 or the like combination, is specified with the same information as the network setting at S11, except the control computer 7. Here, by looking up to the setting of S11, the server section 73 can obtain the IP address of the display apparatus 5 to which the PLC 3 is connected. Therefore, by inquiring the server section 73 via the Internet communication processor 93, the Internet 32, and

the Internet communication processor 80, the SPE 95 allows a user of the SPE 95 to specify the display apparatus 5 in the same manner as the network setting, without his learning a new specifying method.

Detail Description Paragraph:

[0207] Note that, when communicating via the Internet 32 at steps such as S21 or later described S24, the Internet communication processor 80 certifies whether or not the client apparatus 9 or the user thereof is authorized to update the control data, for example by checking whether or not an identification number and a password received from the Internet communication processor 93 are predetermined combination, so that the Internet communication processor 80 will reject an access from an unauthorized client apparatus 9. Because a client apparatus 9 failed to be certified is rejected by the control computer 7 to access, data from that client apparatus 9 will not flow through the network 6. Thus, it is possible to improve security of the local control system 31.

Detail Description Paragraph:

[0209] Further, the control program generating section 94 instructs, for example, an operation system (OS) or the like to transmit the control program to the serial port (S23). Then, the SPE 95 receives the control program instead of the serial port, for example by intercepting a transmission instruction, and generates an identifier that indicates the display apparatus 5 and the PLC 3 set at S21, and instruction data that indicates the received control program. Then, the SPE 95 instructs the Internet communication processor 93 to send the instruction data to the control computer 7 that is set at S21 (S24). In response to this, the Internet communication processor 93 sends the instruction data to the Internet communication processor 80 of the control computer 7, via the Internet 32.

Detail Description Paragraph:

[0210] On the other hand, in the control computer 7, upon receipt of the instruction data, the Internet communication processor 80 instructs the server section 73 to transmit the control program to the display apparatus 5 that is specified in accordance with the instruction data (S25). Further, the server section 73 generates a data string 61p (see FIG. 10), by adding an identification data 62p to a data main body 63p, which is the control program itself, the identification data 62p indicating that the data main body 63p is a control program, and transmits the data string 61p to the IP address of the specified display apparatus 5 (S26).

Detail Description Paragraph:

[0212] The network-size communication processor 52 of the display apparatus 5 judges that the data main body 63p is a control program, in accordance with the identification data 62p of the data string 61p, and instructs the PLC-end communication processor 51 to transmit the data main body 63p as it is. Moreover, the PLC-end communication processor 51 transmits the data main body 63p to the PLC 3 in response to this (S27).

Detail Description Paragraph:

[0214] Note that, in the present control system, discussed is a case where the SPE 95 of the client apparatus 9 designates the display apparatus 5 to specify the PLC 3. However, the present invention is not limited to this. For example, an identifier that can specify the PLC 3 in the whole control system may be added to the instruction data, so that the same effect will be obtained even when the Internet communication processor 80 of the control computer 7 specifies the display apparatus 5 in accordance with the identification.

Detail Description Paragraph:

[0215] However, in case the SPE 95 specifies the PLC 3 in the same method as the setting section 79 as described above, the user of the SPE 95 does not need to learn a method other than that method of the setting section 79. Thus, it is

possible to realize a more user-friendly control system.

Detail Description Paragraph:

[0216] Moreover, in the present control system, exemplified is a case where the PLC 3 makes a response in accordance with the request from the section for displaying or controlling. However, the PLC 3 or the display apparatus 5 may deliver the data every cycle of a predetermined period or every predetermined event. In this case, the transmission for transmission of the data through the network 6 may be defined without considering which type the PLC 3 is of. In any of those cases, a transmission protocol (common protocol) of the display/control data of the network 6 is so defined that the data for the identical control instructions or the identical conditions will be identical when transmitted through the network 6, no matter which type the PLCs 3 are. Thus, the similar effect is obtained as long as the display apparatuses 5 interconvert the common protocol and the designated protocol for each type.

Detail Description Paragraph:

[0217] Next, still another configuration of a control system is explained.

Detail Description Paragraph:

[0218] The control system shown in FIG. 16 is further provided with a public server apparatus 8 for release to the public the data indicating conditions of a local control system 31. In a control computer 7, an Internet communication processor 80 shown in FIG. 12 communicates with a public server apparatus 4 via the Internet 32. In case the local control system 31 and the public server apparatus 8 communicate with each other in cipher, an Internet communication processor 80 uses a predetermined cipher key or a double sign key so as to communicate with the public server apparatus 8 in cipher. The Internet communication processor 80 stores therein various data to be used for connection with the Internet 32.

Detail Description Paragraph:

[0219] The Internet communication processor 80 communicates with the public server apparatus 8 in desired timing, such as at a point of time when received an instruction from a user, and at a point of time when screen data is changed, so as to transmit screen data of the foregoing screen data memory 75 (see FIG. 1) to the public server apparatus 8. Moreover, the Internet communication processor 80 accesses to the public server apparatus 8 in predetermined timing, such as at a point of time when a device 10 is changed and or in a predetermined time interval, so as to transmit to the public server apparatus 8 content (device data) of a device address A that is necessary for releasing data to public in the public server apparatus 8. The content of the device address A is obtained via a server section 73, in the same manner as a display processor 71 obtains. Further, when the Internet communication processor 80 found, as a result of the communication with the public server apparatus 8, that a client apparatus 9 has instructed to change the device data, the Internet communication processor 80 relays the instruction so as to transmit, to an entity of the device address A such as the display apparatuses 5 or the PLCs 3 connected to the display apparatuses 5, the instruction for changing the content, similarly to the case where the display processor 71 changes the content of the device address A.

Detail Description Paragraph:

[0220] The public server apparatus 8 is provided with a local control system end communication processor (hereinafter, just referred to as a local communication processor) 81, a file generating section 82, a display file recording section 83, a data memory 84, and a public server section 85.

Detail Description Paragraph:

[0221] Here, each of the sections 81, 82, 84, and 85 are also functional blocks realized by a program, similarly to the foregoing respecting sections 71 to 77, 91 and 92. Moreover, storing process of a display file into the display file recording

section 83 is also realized by a program.

Detail Description Paragraph:

[0222] An XML (extensible mark-up language) file to be stored in an XML file recording section 83b is generated for each unit screen that is included in screen data of the display apparatuses 5. Each XML file includes an XML element (element), which indicates each tag (process instruction word) that relates to the unit screen.

Detail Description Paragraph:

[0223] The XML file is schematically explained here. For example, in case the screen data of the display apparatus 5 includes, in the format shown in FIG. 4, a display tag WL indicting that base screen (unit screen)=1 (main screen), the XML file that corresponds to the main screen includes a Tag element E1 that corresponds to the display tag WL, shown in FIG. 17. The tag element E1 includes Tag Name element E11, an X element E12, a Y element E13, a Library No. element E14, a Bit Symbol Name element E15, and the like, which correspond to (a) an event name, (b) a display coordinate ranges, (c) a reference file number, and (d) a device address, and the like. The library No. element E14 indicates a registration number of a library tag that is for letting a user to use a figure registered in the library. Moreover, contents of the respective elements E11 to E15 are set to "L.sub.--0000", "-232", "120", "101", and "010100".

Detail Description Paragraph:

[0224] Moreover, for example, in case the screen data of the display apparatus 5 includes an input tag WT in the format shown in FIG. 5, the XML file that corresponds to the main screen includes a Tag element E2 that corresponds to an input tag WT. Further, set in the Tag element E2 so as to have contents in accordance with the contents of the input Tag WT, are Tag Name element E21, a Symbol Name element E22, an X element E23, a Y element E24, an X2 element E25, a Y2 element E26 and the like, which correspond to an event name, a device address, an effective input range and the like.

Detail Description Paragraph:

[0226] An applet to be stored in an applet recording section 83c is realized as a bit code written in Java language that is executable for a virtual machine 91, similarly to the applet used in the control system of FIG. 1. Moreover, the applet includes (a) a class for defining a method corresponding to a type of a tag that can appear in the screen data, and (b) a class for defining a method for calling out, in accordance with the XML file, the method corresponding to the type of the tag. On the contrary, the virtual machine 91 refers to the XML file and calls out the method corresponding to the type of the tag in accordance with the XML element that indicates the tag. Then, the virtual machine 91 executes the method.

Detail Description Paragraph:

[0227] An HTML file to be stored in an HTML file recording section 46 is generated for each display apparatus 5.

Detail Description Paragraph:

[0228] The HTML file includes, as shown in FIG. 18, (a) a character string P11 for causing the virtual machine 91 to execute the applet, and (b) a character string P1 that is necessary as an HTML document such as "<HTML>" and "<TITLE>". Moreover, as shown in FIG. 18, the HTML file may includes a character string P2 that is in a format of HTML, for example, a character string for displaying a word and an image that explain the display apparatus 5 displayed by the applet. Further, the HTML file may include a character string P12 for causing an applet to be executed, the applet being for switching over the unit screens.

Detail Description Paragraph:

[0229] In the present control system, the XML file is provided for each unit

screen. For example, the character string P11 includes information (global information) relating to the whole screen data (the display apparatuses 5), such as designation of a unit screen that is to be displayed first when the browser 92 of the client apparatus 9 displays the HTML file. In case of the present control system, the information is specified as a parameter for executing the applet. For example, the first unit screen is specified as an attribute value (in this example, "1") having an attribute name "BASESCR" of PARAM element.

Detail Description Paragraph:

[0230] The virtual machine 91 is provided with a display page information acquiring section 93, a display processor 94, a communication processor 96, and a screen data memory 97.

Detail Description Paragraph:

[0231] The display page information acquiring section 93 acquires, via the communication processor 96, the Internet 32, a public server section 85, display page information that indicates a unit screen that is currently being displayed, based on the screen data, on the display apparatus 5, the display page information being stored in a display page information recording section 84a of the public server apparatus 8.

Detail Description Paragraph:

[0232] Further, the display processor 94 is provided with a display mode switching section 94a and a remote display page information recording section 94b.

Detail Description Paragraph:

[0233] The display mode switching section 94a switches over, in accordance with instruction from an operator of the client apparatus 9, from/to a coincide display mode in which the client apparatus 9 displays the same unit screen as one the display apparatus 5 currently displaying, to/from a non-coincide display mode in which the client apparatus 9 can display a different unit screen. The remote display page information recording section 94b stores therein remote display page information that indicates a unit screen to be displayed next on the client apparatus 9.

Detail Description Paragraph:

[0234] In the present control system, the file generating section 82 may be provided with generators (not shown) for each specification of the client apparatus 9 (for example for each type of browsers), the generators being for generating, in accordance with the screen data of the display apparatus 5, a specified display file that corresponds to specification of hardware and software of a client apparatus 9 that is expected to access. Moreover, it may be so arranged that the file generating section 82 is provided with one generator so as to generate display files that correspond respectively to specifications of the client apparatus 9, by switching over, for example, by means of a switch.

Detail Description Paragraph:

[0235] Each generator may be so arranged to automatically generate HTML/XML files when the local communication processor 81 receives the screen data from the local control system 31, and to respectively store the HTML/XML files in a predetermined folder that is set in the display file recording section 83 (both file recording sections 83a and 83b). Alternatively, it may be so arranged that the HTML/XML files for the client apparatus 9 is generated by selecting by the use of the public server apparatus, in the file generating section 82, the specification (for example, types of the browser software) of the client apparatus 9 to be displayed, and the files are stored in the specified folder.

Detail Description Paragraph:

[0236] Next, operation of the present control system is explained, referring to a flow chart shown in FIG. 21.

Detail Description Paragraph:

[0237] To begin with, a user of the local control system 2 operates an image processor 74 (see FIG. 1) of the control computer 7, so as to generate or adjust the screen data in accordance with actual conditions of a target system, level of skill of an operator of the display apparatus 5, or what the user likes (S31). The thus generated screen data, for example, is delivered to the display apparatus 5 after being confirmed, for example by simulation or a connection test, that the thus generated data operates normally (S32). Then, the display apparatus 5 starts displaying according to the screen data (S33).

Detail Description Paragraph:

[0238] Next, when the screen data is updated, the control computer 7 (the Internet server communication processor 80) accesses to the public server apparatus 8 (S34). The public server apparatus 8 (the local communication processor 81) performs authentication of the local control system 31 and the user thereof, for example, by comparing combination of pre-stored account and passwords with received combination of account and passwords (S35). If the authentication is succeeded, the screen data is transmitted from the local control system 31 to the public server apparatus 8 (S36).

Detail Description Paragraph:

[0239] After the public server apparatus 8 receives the screen data from the local control system 31, the file generating section 82 generates a display file (a HTML file, alternatively a HTML file and an XML file), in accordance with the screen data (S37). Moreover, the file generating section 82 stores the display file in the generated HTML file recording section 83a and XML file recording section 83b of the display file recording section 83.

Detail Description Paragraph:

[0240] Further, similarly to the aforementioned S5 (see FIG. 8), to display a screen of a display apparatus 5 of a certain local control system 31 is instructed (S38). Similarly to S6, authentication as to whether or not the display and control by the screen is authorized to the user or the client apparatus 9 (S39). Access from an unauthorized user or client apparatus 9 is rejected.

Detail Description Paragraph:

[0241] When it is confirmed that the access is from an authorized and regular user or client apparatus 9, the browser judging section 85a judges which type of browser the client apparatus 9, which sent a request, has (S40). When doing this, the browser judging section 85a detects a browser name recited in a header section of the request from the client apparatus 9, for example. The public server section 85 reads the HTML file, XML file and applet, requested by the client apparatus 9, from among the display files that were generated at S37, and are stored in the display file recording section 83, and transmits the HTML file, XML file and applet to the client apparatus 9 via the Internet 32 (S41).

Detail Description Paragraph:

[0242] Then, the client apparatus 9 extracts an applet element (a part from "<APPLET>" to "</APPLET>") out of the HTML file that the browser 92 received, and causes the virtual machine 91 to execute it (S42). By doing this, the virtual machine 91 communicates with the public server section 85 in accordance with a parameter that is directly given to the applet by the HTML file or a parameter that is given to the applet by the XML file, then performs displaying and controlling similar to those performed by the display apparatus 5.

Detail Description Paragraph:

[0243] The public server section 85, upon receipt of the request from the browser 92, the request being for requesting the display apparatus 5 of the certain local control system 31 to display the screen, reads device data (content of a device

address A), in accordance with the device address A, out of a storing region corresponding to the requested local control system 31 (a region corresponding to a user-use region corresponding to the display file and a region corresponding to the device address A) in a storing region in the data memory 84. Then, the public server section 85 transmits the device data to the client apparatus 9. A drawing method updates a display of a display region (X.multidot.Y) set by the parameter, in the display-use screen of the client apparatus 9 in accordance with the device data, when the requested device data reaches the client apparatus 9 via the Internet 3.

Detail Description Paragraph:

[0244] Moreover, for example an input operation, such as an operation of a mouse, is carried out while the display file is being executed, the virtual machine 91 executes an input method of instance that is in accordance with the input operation, among instances corresponding to input tags in the HTML/XML files. By doing this, the virtual machine 91 requests the public server section 85 to write the data according to an input result into a specific device address A. The public server section 85 rewrites the content of the region of the requested device address A, in the storing region in the data memory 84, upon receipt of a request for rewriting from the client apparatus 9. As a result, reflected onto the display-use screen of the client apparatus 9 is an operation result, similarly to the display apparatus 5, when the drawing method is executed after the writing.

Detail Description Paragraph:

[0245] Here, the operation of the present control system is explained, referring to the flow chart shown in FIGS. 22 and 23.

Detail Description Paragraph:

[0246] To begin with, in case where an operator carries out an input operation to the client apparatus 9, the display processor 94 waits for the input operation by the operator (S51), as shown in FIG. 22. Upon detection of the input operation by the operator, the display processor 94 judges a content of the input operation (S52). Next, when page switching-over is inputted by the operator as a result of the judgment of the input operation (the content of the input operation is "input page switching-over" at S52), the display processor 94 judges, in accordance with setting of the display mode switching section 94a, which display mode is set, the coincidence display mode or the non-coincidence display mode (S53).

Detail Description Paragraph:

[0247] if it is judged that the display mode is the "coincidence display mode", the display processor 94 requests, via the communication processor 96, the public server section 85 to write a specified new page, as display page information, into the display page information recording section 84a (S54). After than, the display processor 94 acquires the XML file by requesting, via the communication processor 96, the public server section 85 to transmit an XML file that corresponds to the display page information (the data of the screen currently displayed). Then, the display processor 94 stores the XML file in the screen data memory 97 (S55).

Detail Description Paragraph:

[0248] On the other hand, if it is judged that the display mode is the "non-coincidence display mode", the display processor 94 writes the specified new page in the remote display page information recording section 94b, as the remote display page information (S56). The display processor 94, then, requests, via the communication processor 96, the public server section 85 to transmit the XML file that corresponds to the remote display page information, and acquires the XML file. Then, the display processor 94 stores the XML file in the screen data memory 97 (S57).

Detail Description Paragraph:

[0249] Further, the display processor 94 acquires the device data by requesting,

via the communication processor 96, the public server section 85 to transmit device data that is necessary for screen display, in accordance with the new XML file acquired from the display file recording section 83, and stored in the screen data memory 97 (S58).

Detail Description Paragraph:

[0250] On the contrary, if the control input is performed by the operator as a result of the judgment at S52 (the content of the input operation is "control input" at S52), the display processor 94 requests, via the communication processor 96, the public server section 85 to write the specified device data into the data memory 84 (S59). After that, the display processor 94 acquires the device data necessary for the screen display, by requesting the public server section 85 to transmit the device data, in accordance with the XML file stored in the screen data memory 97, that is, the XML file that is drawing a screen, whose data the operator instructed to change (S60).

Detail Description Paragraph:

[0251] Finally, the display processor 94 plots so as to update the screen, in accordance with the device data acquired from the data memory 84, and the display file (HTML/XML files and applet) stored in the screen data memory 97 (S61).

Detail Description Paragraph:

[0253] To begin with, the display processor 94 waits for the automatic updating timing of the screen (S71). When the automatic updating timing of the screen comes, the display processor 94 judges, in accordance with the setting of the display mode switching section 94a, which mode the display mode is, the coincidence display mode or the non-coincidence display mode (S72). If it is judged that the display mode is the "coincidence display mode", the display processor 94 acquires, from the display page information acquiring section 93, display page information stored in the display page information recording section 84a (S73). The display processor 94 judges whether the thus acquired display page information has been changed or not (S74).

Detail Description Paragraph:

[0254] If it is judged that the display page information has been changed, the display processor 94 acquires the XML file that corresponds to post-change display page information stored in the display page information recording section 84a, by requesting, via the communication processor 96, the public server section 85 to transmit the post-change display page information. Then, the display processor 94 stores the post-change display page information in the screen data memory 56 (S75). After that, the display processor 94 acquires the device data necessary for the screen display by requesting, via the communication processor 96, the public server section 85 to transmit the device data, in accordance with the new XML file thus acquired from the display file recording section 83 and stored in the screen data memory 97 (S76).

Detail Description Paragraph:

[0255] On the other hand, if the judgment at S72 shows that the display mode is the "non-coincidence display mode", and if the judgment at S74 shows the display page information has not been changed, the display processor 94 acquires the device data necessary for the screen display, by requesting, via the communication processor 96, the public server section 85 to transmit the device data (S78). Here, the display processor 94 carries out the requesting in accordance with the XML file stored in the screen data memory 97, that is, the XML file on which the last plotting is carried out.

Detail Description Paragraph:

[0256] Finally, the display processor 94 plots so as to update the screen, in accordance with the device data acquired from the data memory 84, and the display file (the HTML/XML files and the applet) stored in the screen data memory 97 (S77).

Detail Description Paragraph:

[0257] Here, in the example of FIG. 18, the first unit screen is specified as the attribute value (in this example "1") of the attribute name "BASESCR" of the PARAM element. In this example, if it is in the coincidence display mode, the attribute "BASESCR" is invalidated, so that an initial display is carried out with an initial screen number, which is set in the display apparatus 5. Moreover, if it is in the non-coincidence display mode, the display processor 94 stores, as the remote display page information, "1" in the remote display page information recording section 94b of the client apparatus 9. Then, the display processor 94 acquires corresponding HTML/XML files, and displays a unit screen "1" on the client apparatus 9. Here, the display page information recording section 84a of the data memory 84 stores therein the display page information for indicating the unit screen displayed on the display apparatus 5, regardless of the remote display page information.

Detail Description Paragraph:

[0258] In the present control system, the data memory 84 stores all device data necessary for the screen display, including the display page information for indicating the unit screen currently displayed on the display apparatus 5, so that the local control system 31 and the public server apparatus 8 are synchronized. Therefore, the client apparatus 9 acquires the state of the local control system 31 via the data memory 84, and display the state on the screen, without directly communication with the local control system 31. Namely, it is possible to display, on the client apparatus 9, a screen different from the screen displayed on the display apparatus 5.

Detail Description Paragraph:

[0259] Moreover, in the present control system, requisite is the transmission of the device data. Thus, it is possible to have a simplified setting on the local control system 31 end. Therefore, it is possible to display the state of the local control system 31 on a remote client apparatus, without giving the user of the local control system 31 a burden. Especially, the client apparatus 9 and the local control system 31 do not directly communicate with each other for the screen display on the client apparatus 9. This secures safety of the local control system 31 against the client apparatus 9.

Detail Description Paragraph:

[0260] Moreover, it may be so arranged that the screen data memory 97 stores HTML/XML files for screens designated for the client apparatus 9, which are not to be displayed on the display apparatus 5, so that the screens and the unit screen that is to be displayed on the display apparatus 5 are displayed in a switching-over manner that is performed by the switching-over by the display mode switching section 94a. This makes it possible to establish, on the client apparatus 9, a display-use screen for system data, which is not necessary at a site of operation, or a display-use screen for remote maintenance.

Detail Description Paragraph:

[0261] Note that in the present control system the applet, which is distributed by the public server section 85, perform the display/control in accordance with the XML files indicating the tags (processing instruction words) that respectively relate to the unit screens. However, the present invention is not limited to this.

Detail Description Paragraph:

[0262] For example, as shown in FIG. 20, it may be so arranged that instances corresponding to all the tags included in the screen data are generated as a PARAM element to be recited in the HTML file, and a character string (code) that is set by setting each field of the instances to be in accordance with the contents of the tags. In this case, the file generating section 82 looks up the contents of all the

tags included in the screen data, and generates the character string for calling out the apple for screen display in accordance with a result of the looking-up, as indicated by the character string P11a, and writes the character string in the HTML file.

Detail Description Paragraph:

[0263] In this case, generated as the display file is only the HTML file. Therefore, as shown in FIG. 19, the control system does not require the XML file recording section 87 (see FIG. 16). Thus, in the display file recording section 83, the HTML file and applet are stored in each of the folders that respectively correspond to the specifications of the client apparatus 9.

Detail Description Paragraph:

[0264] Regardless of the operation of the applet and the method of calling out the applet, if the public server section 85 can instruct the client apparatus 9 to operate, namely, to display as the display apparatus 5 in accordance with the state of the device based on the screen data, and to instruct, as the display apparatus 5, the changing of state of the device in accordance with the operation of the operator, the control systems shown in FIGS. 16 and 19 attain substantially similar effects.

Detail Description Paragraph:

[0265] Furthermore, another configuration of the control system is explained below.

Detail Description Paragraph:

[0266] The control system shown in FIG. 24 has a structure basically similar to the control system shown in FIG. 16. However, in the present control system, the client apparatus 9 is further provided with a text editor 98.

Detail Description Paragraph:

[0267] The text editor 98 displays/edits a text file among files stored in a screen data memory 97.

Detail Description Paragraph:

[0268] Referring to the flow chart shown in FIG. 25, operation of the present control system is explained below. To begin with, from S31 to S39, and to S41 and S42, the action is carried out following a procedure similar to that of the flow chart of FIG. 21. When a user of a client apparatus 9 instructs to switch over the screen, a virtual machine 91 reads a new XML file from a public server apparatus 8, and stores it in a data memory 84. Then, the virtual machine 91 displays a unit screen corresponding to the XML file, for example, as shown in FIG. 26 (S43). On the other hand, when a screen of another display apparatus 5 is directed, a HTML file and a XML file are transmitted from the public server apparatus 8 to the client apparatus 9 so as to be stored in a data memory 84.

Detail Description Paragraph:

[0269] Moreover, if the user of the client apparatus 9 wishes to display or operate, at the same time, (a) the state of the device displayed on the unit screen shown in FIG. 2 and (b) the state of the device displayed on the unit screen shown in FIG. 26, the text editor 98 is operated by the user so as to edit the XML file that corresponds to both the unit screens, and generate a new XML file (S44).

Detail Description Paragraph:

[0270] Here, the XML file is, as shown in FIG. 17, a text file and can be edited by a versatile program of the text editor 98 or the like. Moreover, elements of the XML file can be designed hierarchically, so that elements (E11 to E15 and E21 to E26) relating to the contents of the process instruction words are contained below a layer of Tag elements (E1 and E2) corresponding to the respective process instruction words (tags). For example by operating the text editor 98, the unit of

the Tag elements are respectively edited (inserted/deleted) so as to insert or delete, into or from the XML file, an action, such as display action indicated by the process instruction word (tag) or input operation. Note that in the text editor 98, each Tag element is expressed as a series of texts (<Tag> to </Tag> are text).

Detail Description Paragraph:

[0271] Here, in case Tag elements from a plurality of XML files exist together, display areas or input areas relating to the each Tag element may overlap. However, positions of those areas are determined by X elements and Y elements or the likes, and are surrounded by predetermined marks so that those elements relate to coordinates. Therefore, the display areas and the input areas can be moved by adjusting contents of those elements. Thus, it is possible to easily generate a new screen, for example, as shown in FIG. 27. The XML file for displaying the screen is generated by deleting the tag element relating an ON/OFF switch from the XML file of the screen shown in FIG. 26, and by inserting a Tag element relating to switch therein, the Tag element being extracted from the XML file shown in FIG. 2, then by changing the contents of the elements of the Tag relating to the switch, the contents of the elements indicating the display/input areas. Each of those editing actions is an editing action to edit the text, so can be carried out by the versatile text editor 98 without a problem.

Detail Description Paragraph:

[0272] The present control system may be provided with a simulator 86, for example as shown in FIG. 28, instead of the data memory 84 of the public server apparatus 8 shown in FIG. 24. The simulator 86 simulates inputting and outputting of a device of a local control system 31. With this arrangement, it is possible to supervise and control a virtual local control system, instead of the actual local control system 31.

Detail Description Paragraph:

[0274] Alternatively, the present control system may be provided with an applet memory 87, instead of the simulator 86, as shown in FIG. 29. The applet memory 87 stores therein an applet for simulation, which causes the client apparatus 9 to simulate the inputting and outputting of the device of the local control system 31. This makes it possible to deliver the applet for causing the client apparatus 9 to execute the same action as the simulator 86, together with the applet for causing the client apparatus 9 to execute the same action as the display apparatus 5.

Detail Description Paragraph:

[0275] With this arrangement, a public server section 85 transmits, to the client apparatus 9, an applet of the applet memory 87, together with the applet of the applet memory 87. On the other hand, when a virtual machine 91 of the client apparatus 9 executes the applet, a simulator similar to the simulator 86 is formed in the client apparatus 9. Moreover, when the applet stored in the applet memory 87 is executed in the client apparatus 9, the client apparatus 9 inquires the simulator 86 in the client apparatus 9 instead of the public server section 85, so as to perform screen display in accordance with the result of the inquiring to the simulator.

Detail Description Paragraph:

[0276] In those control systems, it is possible to supervise and control the virtual local control system 31, generated by the simulator 86 (or the simulator formed in the client apparatus 9), by using a client apparatus 9 provided in a remote area, while preventing an irregular access to the local control system. Therefore, it is possible to have a virtual experience of the action/action result of the actual display apparatus 5. Thus, for example, those control systems are suitable for training an operator of the display apparatus 5.

Detail Description Paragraph:

[0277] Moreover, in each of the control systems, for example, other mark up

languages such as SGML (Standard Generalized Markup Language) are applicable, besides the XML file, in order to attain similar effects.

Detail Description Paragraph:

[0278] Additionally, in a control system shown in FIG. 30, a control computer 7a of a local control system 31a is provided with a file generating section 82, a display file recording section 83, and a public server section 85, instead of the Internet communication processor 80 (see FIG. 12). However, the public server section 85 accesses to a server section 73 so as to acquire a content of a device address and instructs to change the content of the device address, instead of accessing the data memory 82. Moreover, the file generating section 82 reads out screen data from a screen data memory 75 so as to generate a HTML file and an XML file.

Detail Description Paragraph:

[0281] A control system of the present embodiment is, as shown in FIG. 31, provided with a control host computer (hereinafter, just referred to as a control computer) 1, a plurality of display apparatuses 5, and a plurality of PLCs 3.

Detail Description Paragraph:

[0282] The control computer 1 and the display apparatuses 5 are connected to each other via a network 6, which allows communication in a common communication protocol. On the other hand, the display apparatuses 5 and PLCs 3 are respectively connected to each other via a serial cable 4, which allows communication in a specific communication protocol. Moreover, the display apparatuses 5 are connected to a computer 33 for generating a screen (screen for display). Further, the network 6 is connected to the Internet 32 as a network, via a router (not shown). A client apparatus 9 is connected to the Internet 32.

Detail Description Paragraph:

[0283] In the present control system, similarly to the control system of the first embodiment, a communication protocol (common protocol) common to communication protocols that can be transmitted through the network 6, so that the display apparatus 5 can perform data communication via the network 6 in a universal communication protocol, regardless of which communication protocol is to be transmitted through the serial cable 4.

Detail Description Paragraph:

[0285] The screen generating editor 33a has a substantially equivalent function to that of the screen generating processor 74 (see FIG. 1) of the control system of the first embodiment. The screen data file recording section 33b stores therein screen data for one screen, as one file (screen data file). The screen data is generated by the screen generating editor 33a. The screen data stored therein is transmitted to the display apparatus 5, and downloaded to a screen data memory 54, as required.

Detail Description Paragraph:

[0286] The display apparatus 5, as a control-use display apparatus, is provided with a screen data memory 54, an input section 55b, a serial interface (in figures, I/F) 56, a network interface (in figures, I/F) 57, a data processor 5a, a display section 5b, a conversion data recording section 5c and a maintenance port 5d. The display apparatus 5 is equivalent to the display apparatus 5 of the control system of the first embodiment (see FIG. 1, for example) in terms of basic functions.

Detail Description Paragraph:

[0287] The data processor 5a is provided with a PLC-end communication processor 51, a network-end communication processor 52, a protocol converter 53, and a display processor 55, which are aforementioned. The data processor 5a performs various data processes in order to perform a process for uploading (transmitting) to the control computer 1 a screen stored in the display apparatus 5, in addition to the above-mentioned process of protocol conversion, and display control of the screen.

Detail Description Paragraph:

[0288] In case the serial cable 4 and the network 6 have different communication protocol, the data processor 5a carries out the protocol conversion process so as to convert from one communication protocol to the other, looking up data stored in the conversion data recording section 5c. Moreover, the data processor 5a carries out the display control so as to cause the display section 5c to draw the screen by using VRAM or the like in accordance with the screen data generated by a screen generating editor 33a that is described above. Moreover, the data processor 5a switches over a plurality of screens in accordance with an input of user's instructions to switch over.

Detail Description Paragraph:

[0291] The display section 5b is composed of a flat plate-type display element, such as a liquid panel or an EL panel, in order to compose a display apparatus 5 in a small size, for easy assembly of the display apparatus 5 into a control panel or the like.

Detail Description Paragraph:

[0292] The conversion data recording section 5c stores therein data necessary for protocol conversion process. The data may be in any format that allows mutual conversion of the communication protocol between the serial cable 4 and the network 6. However, the conversion data recording section 5c of the present embodiment stores therein a data transfer format that indicates a format of data to be transferred via the serial cable 4, and a command conversion table (see FIG. 11) that indicates the corresponding relationship between the command codes to be transmitted between the cable 4 and the network 6.

Detail Description Paragraph:

[0295] The control computer 1 is, similarly to the general-purpose personal computer, provided with a CPU, a memory (RAM, ROM or the like), an external recording apparatus (hard disc drive, an MO drive, or the like), a display apparatus, and an input apparatus (a keyboard, a mouse, and the like). Moreover, the control computer 1 is provided with a server section 11, a common protocol IF section (in figures, labeled as I/F) 12, a screen data file recording section 13, a file converting section 14, a file recording section 15 and a public server section 16.

Detail Description Paragraph:

[0296] The common protocol IF section 12 is connected to the network 6 in order to communicate with the display sections 5. The common protocol IF section 12 has a function substantially equivalent to that of the common protocol IF section 72 of the control system of the first embodiment.

Detail Description Paragraph:

[0297] The server section 11 carries out data communication with the display apparatuses 5 via the network 6, collects output data of the PLC 3, which is transmitted from the PLC 3 via the display apparatuses 5, and the like processes. The output data is data (device data) indicating a state of a device (numeral value, On/Off-state, or the like), or an output of the PLC 3 itself (such as an alarm output). Moreover, the server section 11 supplies the output data or the device address to the public server section 16 as required.

Detail Description Paragraph:

[0298] The server section 11 requests the data processor 5a of the display apparatus 5 to upload the screen data in accordance with input instructions of the user, and stores, into the screen data file recording section 13, the screen data thus uploaded via the data processor 5a. Moreover, the server section 11 communicates with the data processor 5a also in accordance with a request from the client apparatus 9 via the public server section 16.

Detail Description Paragraph:

[0299] The screen data file recording section 13 stores therein the file (screen data file) of the screen data uploaded from the screen data memory 54 of the display apparatus 5 by the data processor 5a and the server section 11.

Detail Description Paragraph:

[0301] The display file recording section 15, which has a function substantially equivalent to the display file recording section 83 (see FIG. 16), is provided with an HTML file recording section 15a, an XML file recording section 15b, and an applet recording section 15c.

Detail Description Paragraph:

[0302] The public server section 16 (communication means and acquisition means) has a function substantially equivalent to that of the public server section 77 of the control system (FIG. 1) of the first embodiment. The provision of the public server section 16 enables the control computer 1 to function as a Web server (server apparatus) on the Internet 32.

Detail Description Paragraph:

[0303] The server section 11, the file converting section 14, and the public server section 16 are, similarly to the data processing section 5a, functional blocks that are realized by executing the program supplied by the recording medium. Moreover, also realized by the program is a process of storing the display file in the display file recording section 15.

Detail Description Paragraph:

[0304] In the communication thus arranged, the public server section 16 of the control computer 1 instructs the client apparatus 9 to perform actions substantially equivalent to the display action of the display apparatus 5 to display according to the screen data in accordance with the state of the device, and to the instruction action of the display apparatus 5 to instruct to change the state of the device according to an operation. However, the actions of the client apparatus 9 are different from the actions of the display apparatus 5 according to the screen data in that the data is displayed on a display-use screen of a display apparatus (not shown) of the client apparatus 9, and the operation is inputted via an input apparatus (not shown) of the client apparatus 9.

Detail Description Paragraph:

[0305] Next, with reference to a flow chart of FIG. 32, described are how in the communication the screen data of the display apparatus 5 is displayed on the client apparatus 9, and how the operation is carried out based on the screen thus displayed.

Detail Description Paragraph:

[0306] To begin with, the client apparatus 9 accesses the public server section 16 of the control computer 1 via the Internet 32, so as to instruct the client apparatus 9 to display a screen of the display apparatus 5 (S81). Then, for example by checking whether an identification number, password or the like received from the client apparatus 9 is in the registration, the public server section 16 checks whether or not the client apparatus 9 or the user thereof is authorized for the display/control via the screen (S82). The public server section 16 rejects an access from a client apparatus 9 not in registration.

Detail Description Paragraph:

[0307] If the access is authorized, in the display apparatus 5 the data processor 5a checks whether or not the client apparatus 9 and the user thereof is authorized for the uploading of the screen data (S83), for example by checking the ID number, the password, or the like, about which the public server section 16 inquires via the server section 11, as to whether the ID number, the password, or the like is

registered in the display apparatus 5 in advance. The data processor 5a rejects the uploading of an authorized client apparatus 9.

Detail Description Paragraph:

[0308] If the uploading is authorized, the screen data (screen data file) of the display apparatus 5 is uploaded to the screen data file recording section 13 or the like (S84). Here, the data processor 5a of the display apparatus 5 extracts the screen data specified by the screen data memory 54, and transfers the screen data to the control computer 1. In the control computer 1, the server section 11 receives the screen data, and stores the screen data in the screen data file recording section 13 or the main memory.

Detail Description Paragraph:

[0309] The rest of the procedure is carried out similarly to S37, S41, and S42 of the procedure (see FIG. 21) of the control system (see FIG. 16) of the first embodiment. However, a process of S37 is carried out in accordance with the screen data file uploaded to the screen data file recording section 13. In the process of S37, the control computer 1 synchronizes contents stored in the server section 11, and an entity of the device address stored in the display apparatus 5.

Detail Description Paragraph:

[0310] Note that for synchronizing, decided for example in accordance with changing time and priorities in operation is which of the contents of the server section 11 and the entity of the device address in the display apparatus 5 is to be transferred.

Detail Description Paragraph:

[0311] For example, in case the contents stored in the server section 11 is updated in accordance with the contents of the device address of the display apparatus 5, the server section 11 acquires the contents of the device address, and transmits the contents as device data, as does the display apparatus 5. In an opposite case, where a change in the contents stored in the server section 11 is transferred to the entity of the device address, the server section 11 reads out the device data stored therein when the display apparatus 5 accesses to the server section 11. Then, the sever section 11 transfers the device data to the display apparatus 5.

Detail Description Paragraph:

[0312] Note that again in the present embodiment a format of the files are not limited to the HTML file and the XML file. For example, the file to be displayed in accordance with the device data, such as an HTML file to display data worked out by statistical work of the device data, may be publicized.

Detail Description Paragraph:

[0314] As described above, the communication of the present embodiment is so arranged that the screen data stored in the display apparatus 5 is uploaded so that the file to be publicized is generated in accordance with the screen data, so as to display the screen of the screen data on the client apparatus 9 whereby the operation can be performed via the screen. With this arrangement, it is possible to display on the client apparatus 9 the same screen as that displayed on the display apparatus 5, even if the control computer 1 is, unlike the computer 33, provided with no screen data file recording section 8b designated for storing the screen data. Therefore, it is not necessary to store in the control computer 1 the same screen data as that stored in the screen data file recording section 33b.

Detail Description Paragraph:

[0315] Next, described is another embodiment of the present control system.

Detail Description Paragraph:

[0316] A control system shown in FIG. 33 is provided with a control computer 1, a plurality of display apparatuses 5, a plurality of client apparatuses 9, and a

plurality of PLCs 3.

Detail Description Paragraph:

[0317] In the control system, a public-end common network 34 (local network) is a local network such as the Intranet uniformly using the TCP/IP for communication. By adopting the public-end common network 34 thus arranged, it is possible to use an application program used in the Internet. The public-end common network 34, which is in a network configuration for exchanging information within a closed area such as inside a company, requires a firewall for protection of information that is so important and not to be released to public.

Detail Description Paragraph:

[0319] A screen generating section 17 has a function substantially equivalent to that of the screen generating processor 74 (see FIG. 1) of the control system of the first embodiment. The screen data file recording section 13 stores therein, as one file (screen data file) screen data per one screen of screens generated by the screen generating section 17.

Detail Description Paragraph:

[0320] The communication processor 19 (server-end communication means) communicates with a later-described applet of the client apparatus 9, via a communication processor 96. Moreover, the communication processor 19, which performs a main role in communication process of the control computer 1, performs communication process in response to accesses from the later-described communication processor 96 of the client apparatus 9, accesses from a display file recording section 15 (server-end storing means) and the server section 11 within the control computer 1, accesses to the server section 11 and the communication processor 96. In the communication process, for example, an HTML file, an XML file, or device data is transmitted to an executing section 18 in accordance with a request for an applet stored in an applet recording section 15c, and is transmitted back to the communication processor 96 by accessing to the server section 11 in accordance with a request made by the applet stored in a later-described applet recording section 98c.

Detail Description Paragraph:

[0321] Moreover, the communication processor 19, which has a user account file, uses the user account file so as to perform protecting process that is in accordance with a level of the access from the client apparatus 9. For the protecting process, for example, user names, passwords, access levels, alarm log generation, comments, and the like of each user are set in the communication processor 19. The access levels are for example a level at which only reading of the display content of the display apparatus 5 is authorized, a level at which not only reading but also writing of the display content is authorized, a level at which transmission of a reset command to the display apparatus 5 is validated, and a level at which generation of the alarm log file is authorized.

Detail Description Paragraph:

[0322] The reset command is a command for resetting the display apparatus 5 as a means to restore the display apparatus 5 from troubles such as communication errors. It is possible to perform restoration via the control computer 1 by transmitting such command from the control computer 1. The alarm log file is a file for displaying on the control computer 1 the alarm information from the PLC 3. The alarm log file is stored in the display apparatus 5.

Detail Description Paragraph:

[0325] Here, the client apparatuses are provided with a display file recording section 98 (terminal-end storing means). The display file recording section 98 is provided with an HTML file recording section 98a, an XML file recording section 98b, and an applet recording section 98c. The HTML file recording section 98a and the XML file recording section 98b are respectively stores therein an HTML file and an XML file respectively identical to those stored in the HTML file recording

section 15a and the XML file recording section 15b. The applet recording section 98c stores therein applets generated in advance respectively for specifications of the client apparatuses 9.

Detail Description Paragraph:

[0326] The applets stored in the applet recording section 98c have a function substantially equivalent to those stored in the applet recording section 15c. However, the applets stored in the applet recording section 98c are executed by a virtual machine 91 (display processing means) in order to allow the client apparatus 9 to display thereon the screen to be displayed on the display apparatus 5 thereby allowing operation via the screen. In this point, the applets stored in the applet recording section 98c are different from those stored in the applet recording section 15c. Therefore, the virtual machine 91 for executing the applet refers to the XML file and reads out, in accordance with an XML element indicating a tag, a method suitable to a type of the tag. For example, among methods that the virtual machine 91 executes, a method corresponding to a display tag is the drawing method, and a method corresponding to an input tag is the input method.

Detail Description Paragraph:

[0327] The communication processor 96 (terminal-end communication means) communicates with a communication processor 19 via the public-end common network 34, as requested by the applets. Moreover, the communication processor 96, which plays a main role in communication of the client apparatuses 9, performs communication process in response to accesses from the display file recording section 98 accesses from the communication processor 19, accesses from the virtual machine 91, and the like accesses. In the communication process, the HTML file and the XML file from the respective file recording sections 98a and 98b are downloaded to the virtual machine 91 for example as requested by the applets, while the device data obtained from the server section 11 is acquired by accessing to the communication processor 19.

Detail Description Paragraph:

[0328] In the control system thus arranged, the control computer 1 opens the HTML file stored in the HTML file recording section 15a, when the control computer 1 is instructed to display thereon the screen to be displayed on the display apparatus 5. Then, the execution section 18 extracts each APPLET element ("<APPLET>" to </APPLET>") of the HTML file received via the communication processor 19, and executes the each element. Moreover, the execution section 18 acquires from the XML file recording section 15b via the communication processor 19 the XML file necessary for displaying the screen. Further, the executing section 18, while referring to the XML file, displays on a display section (not shown) provided to the control computer 1 the screen of the display apparatus 5 specified by the HTML file, whereby the executing section 18 instructs control that is in accordance with an operation performed on the screen, by input from an operation section (not shown) also provided to the control computer 1.

Detail Description Paragraph:

[0329] The execution of the applet by execution section 18 makes it possible to display on the control computer 1 the screen to be displayed on the display apparatus 5, and allows input operation via the screen by using the control computer 1.

Detail Description Paragraph:

[0330] Next, described below is a process for displaying on the client apparatus 9 the screen data of the display apparatus 5, with reference to a flow chart of FIG. 34.

Detail Description Paragraph:

[0331] When a user of the client apparatus 9 instructs to display on the client apparatus 9 the screen displayed on the display apparatus 5, the applet stored in

the applet recording section 98c is outputted to default.htm, which is a default file of the HTML file recording section 98a (S91). In this state, the communication processor 96 is activated when the HTML file recording section 98a opens a HTML file corresponding to the desired screen of the display apparatus 5 to be displayed on the client apparatus 9 (S92).

Detail Description Paragraph:

[0332] The communication processor 96 accesses via the public-end common network 34 to the communication processor 19 in the control computer 1. Then, the communication processor 19, using the setting of security described above, checks whether or not the client apparatus 9 or the user is authorized for the display/control using the screen (S93), for example by checking whether or not a user name, a password or the like received from the client apparatus 9 is in registration. An access from an unauthorized client apparatus 9 would be rejected. At the same time, an access level is also checked.

Detail Description Paragraph:

[0333] If the access is authorized, the communication processor 96 accesses to the server section 11 via the communication processor 19, so as to instruct to display the screen of the display apparatus 5 (S94). The communication processor 19 limits the access through the server section 11 to data of the display apparatus 5, in accordance with the predetermined access levels.

Detail Description Paragraph:

[0334] Next, a browser 92 of the client apparatus 9 acquires the HTML file from the HTML file recording section 98a via the communication processor 96, and acquires, again from the HTML file recording section 98a, an applet specified by each APPLET element (a part from "<APPLET>" to </APPLET>") in the HTML file, so as to cause the virtual machine 91 to execute the applet (S95). Moreover, the virtual machine 91 acquires the XML file necessary for displaying the screen, via the communication processor 96 from the XML file recording section 98b, so as to generate instances respectively in accordance with processing instruction words, while looking up the XML file (S96). Of those instances, a drawing method of the instance corresponding to the instruction word for display is executed in a predetermined time interval. As a result, the virtual machine 91 inquires the server section 11 about the content of the device address A via the communication processor 96 and the communication processor 19 (S97).

Detail Description Paragraph:

[0335] On the other hand, the server section 11, when inquired, reads data out of an area corresponding to the device address A within a recording area of the user corresponding to the applet, and transmit the data to the client apparatus 9 by communication (S98). When the data is transferred to the client apparatus 9 via the public-end common network 34, the drawing method updates a display of a predetermined display region (X, Y) on the screen displayed on the client apparatus 9, in accordance with the data (the content of the device address A) (S99).

Detail Description Paragraph:

[0336] The HTML file includes a plurality of applets. Each applet draws, from the browser 92, relative coordinates (for example, relative coordinates having its origin at its left upper corner). This allows the client apparatus 9 to display the state of the device, regardless of a number and an order of the applets included in the HTML file.

Detail Description Paragraph:

[0337] On the other hand, the virtual machine 91 executes an input method of the instance corresponding to the input operation of the instances corresponding to the processing instruction words for input use, when input operation, such as operation of a mouse, is performed. By doing this, the virtual machine 91 requests, via the respective communication processors 96 and 19, the server section 11 to write the

data according to an input result in a specified device address. The server section 11 rewrites the content in the area of the device address A, which is requested, within the recording area. The rewritten content is transmitted to the display apparatus 5 via the network 6. As a result, the result of the operation is reflected on the screen displayed on the client apparatus 9, similarly to the display apparatus 5, when the input method is carried out after the writing.

Detail Description Paragraph:

[0338] This allows the client apparatus 9 to display the screen having the same content as that of the display apparatus 5, and to control the state of the device in the same operation, even if the client apparatus 9 is in a location remote to the display apparatus 5 and connected to the control computer 1 via the public-end common network 34.

Detail Description Paragraph:

[0339] As described above, the control system of the present embodiment is so arranged that the applet installed in each client apparatus 9 inquires, via communication between the communication processors 96 and the 19, the server section 11 of the control computer 1 so as to cause the virtual machine 91 to instruct for display action and the changing in contents of the device address. With this arrangement, it is possible to see, one the client apparatuses 9 located remotely from the location of the display apparatus 5, the content of the screen displayed on the display apparatus 5 at the same time the screen is displayed on the display apparatus 5. Moreover, it is possible to operate on the screen on the client apparatus 9.

Detail Description Paragraph:

[0340] Moreover, because the control computer 1 is provided with the execution section 18 capable of accessing the communication processor 19, so that the control computer 1 executes the applet stored in the applet recording section 15c. Therefore, it is possible to see, also at the control computer 1, the content of the screen displayed on the display apparatus 5 at the same time the screen is displayed on the display apparatus 5. Again, it is possible to operate on the screen at the control computer 1.

Detail Description Paragraph:

[0342] Moreover, in the present control system, in which the control computer 1 has no software for the Web server, it is impossible to utilize a security function of the software for Web server against accesses from the client apparatus 9. However, its security is improved because the access to the data of the display apparatus 5 is limited by the access level that is set in advance for each user. Moreover, this access limiting method does not authorize or reject accesses collectively in all level unlike a general access limit in the Internet communication. Instead, in the access limiting method it is possible to set at individual levels as to whether authorized or rejected, but not wholly at all the levels. Therefore, for example, it is possible to authorize a higher leveled access to a user of an important position regarding the communication, such as a system administrator.

Detail Description Paragraph:

[0343] Yet another modification of the present control system is explained below.

Detail Description Paragraph:

[0344] In a control system shown in FIG. 35, client apparatuses 9 are connected so as to be capable of performing Internet communication with a control computer 1 via the Internet 32 as a public network.

Detail Description Paragraph:

[0345] The control computer 1 of the present control system is further provided with a CGI (Common Gateway Interface) 20.

Detail Description Paragraph:

[0346] A browser 92, when instructed to access the control computer 1 and causes the control computer 1 to display on the client apparatus 9 a screen as a Web page, recognizes it, and recognizes that communication using HTTP is to be carried out. On the other hand, the browser 92 of the client apparatus 9, when instructed to cause the client apparatus 9 to display the screen, recognizes that communication via a communication processor 96 is to be carried out when an HTML file stored in an HTML file recording section 98a is opened.

Detail Description Paragraph:

[0348] In this control system, a server section 11 has functions (a) to count up how many nodes are accessing to the communication processor 19 from the client apparatus 9 via the CGI 20, and how many time relay accesses are made via the communication processor 19 to other stations, and (b) to display the counting. This makes it easier to control the accesses, so as to understand the state of the communication access to the communication processor 19, thereby checking for unauthorized accesses.

Detail Description Paragraph:

[0349] Next, explained with reference to a flow chart of FIG. 36 is a process to display on the client apparatus 9 screen data of the display apparatus 5, in the communication.

Detail Description Paragraph:

[0350] To begin with, a user instructs, via the Internet 32, to cause the client apparatus 9 to access via the public server section 16 of the control computer 1 so as to display a screen of a certain display apparatus 5 (S101). Then, the public server 16 checks whether or not the display/control on the screen is authorized to the user or the client apparatus 9, for example, by checking whether or not an ID number, a password, or the like received from the client apparatus 9 is the one registered in advance (S102). An access from an unauthorized client apparatus 9 is rejected. Here, the communication processor 19 checks whether or not the client apparatus 9 is authorized to access the communication processor 19, as described previously (as at S93 of FIG. 34).

Detail Description Paragraph:

[0351] If the access is authorized, a file converting section 14 generates a public file such as an HTML file and an XML file, based on a screen data file stored in a screen data file recording section 13, when receiving a request for generating the public file from the client apparatus 9 by accessing the communication processor 19 via the CGI 20. Then, the file converting section 14 stores the public file in an area for the user in an HTML file recording section 15a and an XML file recording section 15b (S103). Only for a regularly authorized client apparatus 9, the public server section 16 reads, from the HTML file recording section 15a, the HTML file for displaying a screen requested by the client apparatus 9 so as to transmit the file, from the communication processor 19 to the client apparatus 9, via the CGI 20, the public server section 16, and the Internet 32 (S104). Further, the client apparatus 9 uses the file to display the screen (S105).

Detail Description Paragraph:

[0352] Again in the present system, distributed is the applet for causing the client apparatuses 9 to inquire, to instruct the changing, and to display, similarly to the control system of FIG. 33 described previously. Thus, it is possible to significantly reduce an amount of data to be transmitted, thereby improving response speed of the client apparatus 9 significantly. Moreover, the response speed can be further improved because user interface, such as moving a cursor, can be performed on the client apparatus end.

Detail Description Paragraph:

[0353] As in the first embodiment, the present control system is not limited to the

HTML file and XML file in terms of the file format.

Detail Description Paragraph:

[0354] Moreover, the present control system may be arranged as shown in FIG. 37.

Detail Description Paragraph:

[0355] The control system is so arranged that one client apparatus 9 can access a control computer 1 via a public-end common network 34 and the Internet 32. Thus, in order to display on the client apparatus 9 a screen in accordance with a file of the control computer 1, a browser 92 recognizes it as described above, and causes a communication processor 19 to perform communication via the Internet 32. On the other hand, in order to display a screen according to a file of the client apparatus 9, the browser 92 recognizes it and causes the communication processor 19 to perform communication via the public-end common network 34.

Detail Description Paragraph:

[0356] Therefore, in such control system, a process according to the communication selected by a user is carried out simply by the user's selecting either of the communications. Thus, the user can display the screen and operate on the screen thus displayed, without paying attention to the difference between the ways of communication. As a result, the user can utilize, without a special operation, the communication via the CGI 20 and the Internet 32, which is a general Internet, and the communication via the public-end common network 34, the later communication being faster than the former one.

Detail Description Paragraph:

[0359] A control system of the present embodiment is, as shown in FIG. 38, provided with a control host computer (hereinafter, denoted as a control computer) 2, a plurality of display apparatuses 5, a plurality of PLCs 3, and a client apparatus 9.

Detail Description Paragraph:

[0360] The control computer 2 and the display apparatuses 5 are connected with each other via a network 6 (common network), with which communication in a common protocol is possible. On the other hand, the display apparatuses 5 and PLCs 3 are respectively connected with each other via a serial cable 4 (designated network), with which communication in a specific communication protocol is possible.

Detail Description Paragraph:

[0361] Note that broadly-sensed communication protocols include (a) communication protocols in which data cannot be normally transmitted when a sender and a receiver do not have the same code for representing start characters and end characters, the same timing for sending and receiving the characters, and the same methods for specifying senders and receivers, and (b) communication protocols in which normal control is not possible when the sender and receiver do not have the same command system for command system that each PLC 3 can understand, because an action one of the sender and receiver desires is not identical to an action the other performs. Therefore, in the following explanation, the combination of the two kinds is denoted as communication protocol. Where it is necessary to distinct the two kinds, the former is denoted as a transmission protocol, and the latter is called as a command system.

Detail Description Paragraph:

[0363] Thus, in the present embodiment, in case the display apparatus 5 performs data communication via the network 6, a communication protocol (common protocol) common to communication protocols that can be transmitted through the network 6, so that communication will be performed in a unified communication protocol regardless of the communication protocol transmitted through the serial cable 4.

Detail Description Paragraph:

[0365] Here, the display apparatuses 5 are provided with a data delivery section 5e. The data delivery section 5e delivers output data of the PLC 3 to a specified receiver of delivery, when predetermine delivery conditions are satisfied. Thus, the data delivery section 5e stores therein node information as to a node of the receiver of delivery, setting information as to the delivery, the information being downloaded from the control computer 2 in advance.

Detail Description Paragraph:

[0366] The control computer 2 is provided with a sever section 21, a common protocol IF section (in figures, I/F) 22, a delivery setting section 23, a network file 24, a data registering section 25, an application section 26, a database 27, a data memory 28, a compiler 29, and a public server section 30.

Detail Description Paragraph:

[0367] The interface section 22 is connected to the network 6 for communication with the display apparatuses 5. The common protocol IF section 22 has a function substantially equivalent to the common protocol IF section 72 (see FIG. 1) of the control system of the first embodiment.

Detail Description Paragraph:

[0369] The data communication processor 21a is a section for carrying out the data communication process with the display apparatuses 5 via the network 6 and for exchanging data with the application section 26. The data communication processor 21a, for example, transmits a screen generated by a later-described screen generating editor 26a, a ladder program generated as a user program generated by a ladder editor 26b, and collects a screen delivered from the display apparatus 5, a ladder program delivered from the PLC 3 by the display apparatus 5, and input data (control instruction data) and output data of PLC 3. The input data indicates which part of contents (bit, numeral values) of a later-described device address of an input apparatus is to be changed. The output data is a content to be outputted by an output apparatus.

Detail Description Paragraph:

[0370] The database administrating section 21b (storing means and searching means) registers in the database 27 the screen and ladder program delivered from the display apparatus 5, and the input data and the output data of the PLC 3., and search through the data registered in the database 27.

Detail Description Paragraph:

[0371] More specifically, the database administrating section 21b sets folders named for each display apparatus 5 in the data base 27, and prepare records by combining the screen displayed on the display apparatus 5 or the ladder program executed by the PLC 3 with a symbol as a changing element for the screen or a ladder symbol (components and tag) as a changing element for the ladder program, the device address, the input data, and the output data. The database administrating section 21b registers the records in the folders in order of their generation. As folder names, for example, station names of the display apparatuses 5 such as "NODE A" indicated by A as shown in FIG. 38, or product type name of the display apparatuses 5, are appropriately used. Moreover, the database administrating section 21b searches for a record relating to a time specified by the folder specified by the user, and passes down the searched-out record to the screen generating editor 26a or the ladder editor 26b so that the screen generating editor 26a or the ladder editor 26b can display the record.

Detail Description Paragraph:

[0374] The database administrating section 21b continuously searches data so as to cause the screen generating editor 26a or the ladder editor 26b to dynamically display in accordance with operation of the reproduction key 101a. When the fast-forward key 101c or the fast-backward key 101d is operated during the searching, the searching is sped up so as to display the search screen in a forward or a

backward direction at a high speed. On the other hand, when the pause key 101e is operated during the searching, the searching is temporally stopped so as to display the screen in pause. Moreover, when only the fast-forward key 101c or the fast-backward key 101d is operated, searching location is changed at a high speed, but the screen is not displayed (reproduced). Meanwhile, the day/time setting section 101a displays thereon day and time that are recognized when the searching location is moved. Further, the operation of the stop key 101c stops the searching.

Detail Description Paragraph:

[0375] The search screen 101 is searched out and displayed on a reproduction screen 52 displayed by the screen generating editor 26a or the ladder editor 26b. It is possible to move the search screen 101 to a desired location by dragging and dropping by using a mouse or the like. With such search screen 101, the user is provided with an environment in which the user can perform the searching in the same fashion as the user uses an audio apparatus.

Detail Description Paragraph:

[0377] The delivery setting section 23 sets the node information and delivery information. The node information contains the nodes in the network 6, and types of the display apparatuses 5 connected to the nodes. The delivery information contains names of devices 10 connected to the PLCs 3 (the input apparatuses and the output apparatuses), timings of data delivery for each display apparatus 5, store addresses of data to be delivered, and store addresses of data received. The node information and the delivery information are stored in the network file 24, and downloaded to the data delivery section 5e of the display apparatuses 5 as required. The delivery setting section 23 is also a functional block realized by executing a program provided by a recording medium, similarly to the data processor 5a.

Detail Description Paragraph:

[0378] The data registering section 25 registers therein in advance the aforementioned protocol converting data to be recorded in the converting data recording section 5c. The converting data is downloaded via the data communication processor 5a to the display apparatus 5 that requires the converting data, for setting an initial setting, and for maintenance, such as changing the PLC 3 to be connected to the control system.

Detail Description Paragraph:

[0380] The screen generating editor 26a has a function substantially equivalent to the screen generating processor 74 (See FIG. 1) in the control system of the first embodiment. A screen generated by the screen generating editor 26a is transferred to the display apparatus 5 via the interface section 12 if necessary, and is downloaded to the screen data memory 54.

Detail Description Paragraph:

[0381] The ladder editor 26b is programming software for generating a ladder program for setting control procedure of the PLC 3 so as to cause the device 10 to operate in accordance with a desired sequence. The ladder editor 26b is so constituted that the ladder editor 26b can generate a ladder diagram on a display device (not shown) of the control computer 2 by arranging a ladder symbol corresponding to an action of the device 10. The ladder editor 26b uses, for example, the aforementioned programming languages in conformity of the international standard IEC.

Detail Description Paragraph:

[0384] The ladder program generated by the ladder editor 26b is transferred to the PLC 3 via the display apparatus 5 (or directly) and downloaded in the memory inside the PLC 3.

Detail Description Paragraph:

[0385] The database 27 manages data sequentially written by the database administrating section 21b for each folder. For example, in the screen displayed on the display apparatus 5 of NODE A, provided as fields are items such as "date", "screen", "preset temperature", "level", "preset pressure", "level", and "alarm", as shown in FIG. 41(a). "Date" is indicated on the minute time scale in FIG. 41(a); however, it may be stored on the second or millisecond time scale if necessary. The "screen" indicates a file name of the screen. The "preset temperature" and "preset pressure" indicate a temperature and a pressure preset as operating instructions, respectively. The "level" indicates actual temperature and pressure with respect to the preset temperature and pressure. When the preset temperature and pressure are in the predetermined range, alarm sets the value "0" which indicates as being normal. When not in the predetermined range, alarm sets the value "1" which indicates as being abnormal.

Detail Description Paragraph:

[0399] The "switch-on" is a condition for delivering upon the switch-on of the display apparatus 5, and "time specification" is a condition for delivering at a specified time. The "cycle specification" is a condition for delivering for each desired cycle, and "rewriting trigger" is a condition for delivering when output data is rewritten, that is, when output data changes. The "ON period" and "OFF period" are conditions for continuing a delivery in the ON period and the OFF period of a device, respectively. The "rising trigger" and "falling trigger" are conditions for delivering upon detecting the increase and decrease of the output data (specified device output), respectively.

Detail Description Paragraph:

[0401] On the other hand, in "delivering station/receiving station shown in FIG. 43 (b) provided are information filing sections about the receiving station and the receiving station. The information of the delivering station includes a name of a device which is an output source of output data delivered from the display apparatus 5 and numbers of data delivered in a specified period. Further, the information of the receiving station includes a name of a device connected to the PLC 3 corresponding to the display apparatus 5 that is a receiving station. Incidentally, it is defined that in case where the control computer 2 is a receiving station, a folder name managed in the database 27 is a device name.

Detail Description Paragraph:

[0402] In the control system arranged as described above, in case where receiving the data string 66 of the common protocol via the network 6, the data processor 5a extracts from the data main body 63 the common code 64 for representing the command to be transmitted to the PLC 3, and the relevant information 65. Further, the data processor 5a refers to the command conversion table TBL and selects a command code corresponding to the common code 64, which is transmittable to the serial cable 4. Moreover, if necessary, an expressing method of the relevant information 65 is converted into an expressing method transmitted by the serial cable 4. As a result of these, when a command to be transmitted to the PLC 3, data content itself, data size and address, etc. are determined, the data processor 5a refers to the data transmission format FMT to generate a data string to be transmitted to the PLC 3.

Detail Description Paragraph:

[0403] On the other hand, when receiving the data string 41 from the PLC 3, the data processor 5a applies it to the foregoing data transmission format FMT, extracts a command that the data string shows, data content itself, data size, address, etc., and converts them into the data string 66 of the common protocol in the inverse procedure of that described above.

Detail Description Paragraph:

[0404] Before the display apparatuses 5 and PLCs 3 transmit the data regarding the control, combination (protocol information) between the data transmission format FMT and the command conversion table TBL is set in accordance with the

communication protocol of the PLCs 3, so that the protocol information is changed over when a PLC 3 using a different communication protocol is connected. For example, if a PLC 3 of type A is replaced with a PLC 3 of type B, a command conversion table TBLa is changed over to a command conversion table TBLb, which are shown in FIG. 11.

Detail Description Paragraph:

[0405] Note that, a method of selecting the communication protocol is carried out similarly to the foregoing method carried out in the control system of the First Embodiment (see FIG. 1).

Detail Description Paragraph:

[0406] Thus, unlike the conventional control system, in the present control system, the display apparatuses 5 are provided in a central position in the communication, and the display apparatuses 5 are connected to both the network 6 and the serial cable 4. Moreover, in case of the difference of the communication protocol between the serial cable 4 and the network 6, the display apparatuses 5 inter-converts the respective communication protocols and relays the communication between (a) the PLC 3 to which that display apparatus 5 is connected, and (b) the control computer 2 or another display apparatus 5. In this manner, the control computer 2 and each display apparatus 5 can communicate with each other in the common communication protocol even if different dedicated protocols are used between the PLCs 3 that are respectively connected to the display apparatuses 5.

Detail Description Paragraph:

[0407] More specifically, the target system is provided with input apparatuses such as a flow sensor, a temperature sensor, or a sensor, which detects a state of respective components in the target system, output apparatuses such as a valve or a motor, which operates in accordance with instructions, and the devices 10 which are controlled by the PLCs 3. Further, because the PLCs 3 have been developed from the sequencer, most PLCs 3 are provided with their own communication protocols, for example, by manufacturers of the PLCs 3, product classes, and types of the PLCs 3. Therefore, the PLC 3, which is connected with the display apparatus 5 via the serial cable 4, communicates with the display apparatus 5 in the communication protocol in which the PLC 3 can communicate.

Detail Description Paragraph:

[0408] This makes it possible that the PLC 3 transmits the data, which is obtained by the input apparatuses, as output data of the PLC 3 to the display apparatus 5 or to other display apparatus 5 or the control computer 2 via the display apparatus 5, while the PLC 3 receives control instruction transmitted from the display apparatus 5 or from other station via the display apparatus 5 to control the output apparatuses.

Detail Description Paragraph:

[0409] As described above, in the control system in which transaction for determination of a common communication protocol is carried out in the network 6, it is possible to easily deliver data of screen and device address between each display apparatus 5 and the control computer 2. Next, the delivery will be described in detail.

Detail Description Paragraph:

[0410] Here, the following will describe an arrangement in which the nodes A to C in the network 6 are connected to the respective display apparatuses 5, each of which is independently connected to the PLC 3, each of which includes 100 input and output terminals. In such an arrangement, with respect to the output terminals of each PLC 3, control data inputted by the operator with the display apparatus 5 is stored in a store region corresponding to the memory in the PLC 3, and the output apparatus 7 is controlled in response to the stored content. With respect to the input terminals of each PLC 3, input data supplied from the input apparatus 6 is

written in the store region corresponding to the foregoing memory.

Detail Description Paragraph:

[0411] For example, in each store region corresponding to one hundred input output terminals in each PLC 3 corresponding to the nodes A to C, store addresses are allocated, numbered 100 to 199, 200 to 299, and 300 to 399. The data delivery section 5e in the display apparatus 5 of the node A delivers data in the store region numbered 100 to 199, that is, all input and output data at cycles (for example, 10 seconds) preset by the foregoing delivery setting section 13. The data are stored in the control computer 2.

Detail Description Paragraph:

[0412] Moreover, when the delivery condition "rising trigger" is set, and a bit representing various information such as error (alarm) information of a device and information on operating instructions corresponding to device output is provided in the store region corresponding to each device in the memory of the PLC 3, node information (station name) of the PLC 3 to which the device is connected as well as the delivery condition is transmitted from the display apparatus 5 of the node when the bit is ON.

Detail Description Paragraph:

[0413] Further, the control computer 2 stores all data that are transmitted from each display apparatus 5. Each display apparatus 5 includes data delivery section 5e, which is provided with a store region necessary for storage of delivery data therein.

Detail Description Paragraph:

[0414] Data loading in the control computer 2 may be carried out in such a manner that a receiver's address is stored in delivery data from the delivery source, for example, in the IP address. Further, in case of many receivers including display apparatuses 5, etc., not just the control computer 2, the data loading may be carried out in such a manner that the IP address is LAN broadcasted, and the receivers determines whether data is loaded or not in response to the IP address of the delivery source of the delivery data. Also, needless to say, all display apparatuses 5, similarly to the control computer 2, may have storing region corresponding to all delivery data so as to store therein all delivery data.

Detail Description Paragraph:

[0415] As described above, when the delivery condition is established, not only data delivery is possible between each display apparatuses 5 and the control computer 2, but also delivery data is sequentially stored in database 27 of the control computer 2, regarding the establishment of the deliver condition as a trigger, so that it is possible to search desired records from the database 27. Next, the operation will be described in detail.

Detail Description Paragraph:

[0416] For example, input data (the content of the device address of the input apparatus 6) and output data (the content of the device address of the output apparatus 7) of the PLC 3 collected in the display apparatus 5 of the node A are delivered to the control computer 2 together with the device address via the network 6. Then, they are loaded from the common protocol IF section 22 to the server section 21 and transferred to the database administrating section 21b. The database administrating section 21b sequentially writes records inputted continuously into the database 27, regarding data inputted at the same time in the folder of the node A as one record. Such writing is automatically performed, so that the user can store data without considering the database 27.

Detail Description Paragraph:

[0417] In case where searching is carried out in the database 27, an operation mode of the server section 21 is changed over to a search mode to activate the searching

screen 101 as shown in FIG. 40. Here, in case where records are searched in the order of date of storage, searching is started in a folder specified by operation of the reproduction key 101b. During searching, records are sequentially read out from the database 27 by the database administrating section 21b and are outputted to the screen generating editor 26a. The screen generating editor 26a reproduces the screen in accordance with the screen in the received record and data of the device address and the symbol, and shows the screen on the display of the control computer as a reproduction screen 102 shown in FIG. 40. Such a series of operations are continuously performed, so that it is possible to dynamically reproduce change of the screen on the display, similarly to the screen displayed on the display apparatus 5 when the PLC 3 have operated actually.

Detail Description Paragraph:

[0418] Moreover, in case where only the record corresponding to the specified key is read out in accordance with the preset key, the operation of the reproduction key 101b by specification of alarm as a key enables the readout of the record upon the occurrence of the alarm, and the record is reproduced by the screen generating editor 26a. Thus, not only the specification of the alarm as a key enables the display of the screen upon the occurrence of the alarm, but also further reproduction of screens before and after the occurrence of the alarm makes it possible to check what operations are performed before the occurrence of the alarm, or what operations are performed for recovery after the occurrence of the alarm.

Detail Description Paragraph:

[0421] In case of the ladder program, the ladder program executed in the PLC 3 is delivered to the control computer 2 via the display apparatus 5 and is written in the database 27 by the database administrating section 21b. In searching, a searched ladder program (not shown) is reproduced instead of the reproduction screen 102 shown in FIG. 40. In case of reproduction of a ladder program monitor, the ladder program is reproduced in the range of an area of the selected ladder program monitor. Contact points and operations of coils, etc. searched in the ladder program are expressed, for example, by changing colors of these parts.

Detail Description Paragraph:

[0426] Thus, the screen that has been actually displayed on the display apparatus 5 or the ladder program that has been actually executed in the PLC 3, which are stored in the database 27, is outputted as the applet to the public server 30. The public server section 30 transmits the applet from the interface section 12 to the client apparatus 9 via the network 6 and the Internet 32.

Detail Description Paragraph:

[0427] In the client apparatus 9, the browser 91 activates the virtual machine to execute a drawing method using the device address and the input and output data, which are supplied from the control computer 2, so that the screen is displayed similarly to the display state in the display apparatus 5, or the screen is displayed in the state that the ladder program reflects the operation state of the PLC 3. In this manner, even in the client apparatus 9 at the position away from the control computer 2, searching is performed as in the case of the control computer 2.

Detail Description Paragraph:

[0428] As described above, in the control system of the present embodiment, the display apparatus 5 absorbs the difference of the communication protocol between the types of the PLCs 3, which makes easy data communication between each display apparatus 5 and the control computer 2. Therefore, it is possible to easily collect the output data from different types of PLCs 3 in the control computer 2. Further, using the data delivery function by the data delivery section 5e, every time the set delivery conditions are satisfied, data is delivered from the display apparatus 5 to the control computer 2, and the data is stored sequentially in the database 27 by the database administrating section 21b, so that it is possible to collect and

store data efficiently, unlike the conventional data collection software, which requests for transmission of data from a personal computer while communicating with the PLC. Therefore, the user can establish the database 27 without consideration.

Detail Description Paragraph:

[0430] Moreover, operations in the display apparatus 5 can be reproduced by reflecting the input and output data obtained by searching to the screen or the ladder program. Therefore, unlike a VTR recording motion pictures, it is not necessary to store a large amount of data, as well as searching makes it possible to check the screen and the ladder program when operating errors occur. Especially, it is possible to easily specify the moments when the operating errors occur by searching which regards alarm as a key. Also, when continuous searching is performed by using the search screen 101 as shown in FIG. 40, change of the symbol of the screen and the ladder symbol of the ladder program by input data and output data is dynamically displayed, so that it is possible to reproduce the screen and the ladder program similarly to the reproduction in video reproduction apparatuses such as a VTR.

Detail Description Paragraph:

[0431] Thus, reproduction of the executed screen and ladder program is utilized not only for verification of operating errors, etc., but also for education of operators. For example, an operating content of the display apparatus 5 can be reproduced repeatedly without operating a target system, so that the operating content by a veteran operator can be sufficiently utilized as a textbook.

Detail Description Paragraph:

[0433] Note that, in the present embodiment, as the network 6, TCP/IP on the Ethernet is adopted; however, the network 6 is not limited to this. For example, IEEE1394, or other networks may be adopted. A similar effect can be obtained, provided that the network has communication capacity so sufficiently that the control computer 2 can communicate with each PLC 3 via the display apparatus 5.

Detail Description Paragraph:

[0434] Further, in the present embodiment, an example using a ladder program is shown. However, needless to say, the control procedure program of the present invention can be adopted for a control procedure program by other languages including five languages defined in the foregoing IEC 6 1131-3, besides the ladder program. Meanwhile, a user program may be the foregoing CAD drawing, etc. besides a display content program (screen) and control procedure program and a control procedure program, provided that the user program is a program that shows the control state by the PLC 3.

Detail Description Paragraph:

[0438] (1) A control server apparatus of the present invention and a control system of the present invention including the same is so arranged that data indicating a screen of a programmable display apparatus is converted into such a format that the screen can be displayed on a terminal apparatus in that format, and then is transmitted. As a result, a screen having the same content as the screen displayed, via the Internet or the like, on the programmable display apparatus can be displayed on the terminal apparatus in a remote area, without putting a burden on a control apparatus.

Detail Description Paragraph:

[0439] (2) A control terminal apparatus of the present invention is so arranged that the control terminal apparatus can transfer an instruction of updating a control program, to a local control system including a control unit to receive the instruction, even in case a conventional control program generating means, which is capable of outputting the control program only to a serial port, is utilized. As a result, it is possible to update the control program of the control unit from a remote area, by utilizing the conventional control program generating means,

without newly generating, for each type of control units, a control program generating means, which is capable of outputting the control program via a wide area network. Moreover, the control program can be updated in a short time even if a staff of generating a control program is not positioned in a vicinity of the local control system. Thereby, it is possible to reduce labor of maintenance.

Detail Description Paragraph:

[0440] (3) With a control system of the present invention, it is possible to display on a terminal apparatus located in a remote area from a control display apparatus, a display-use screen to be displayed on the control display apparatus. Further, because the screen data is acquired from the control display apparatus, it is not necessary to store the screen data in a server apparatus having a generating means and a communication means. Thus, it is possible to display the display-use screen to be displayed on a control display apparatus more easily.

Detail Description Paragraph:

[0441] (4) With a control system of the present invention, display on a terminal apparatus located in a remote area from a control display apparatus, a display-use screen identical to a display-use screen to be displayed on the control display apparatus. Moreover, because communication between a server apparatus and a terminal apparatus is carried out by communicating between a server-end communication means and a terminal-end communication means via a local network, it is possible to effectively perform the communication at a relatively at a high communication speed, without using a communication system, which is performed via software for Web server, and which has a relatively low efficiency, for example a general Internet communication.

Detail Description Paragraph:

[0442] (5) With a control system of the present invention, it is possible to for a display-type control apparatus to communicate with a host computer always in the same communication protocol via a common network, regardless of which communication protocol the control apparatus uses. As a result, a host computer can easily accumulate an output data from the control apparatuses having different communication protocol.

Detail Description Paragraph:

[0444] Further, because a searched out user program is continuously displayed, a status of the user program at a time the control apparatus was in action can be reproduced. Further, in the terminal apparatus, when the execution program is executed, the change elements in the user program are changed in accordance with both the data. As a result, for example, states of changing the symbols of the change elements are displayed on the screen. Thus, the transmission of the user program in a format of the execution program enables the terminal apparatus in a network such as the Internet to search and check data accumulated in the host.

CLAIMS:

1. A control server apparatus, comprising: a display apparatus-end communication means, connected to a programmable display apparatus, for receiving data indicating a screen of the programmable display apparatus; a converting means for converting the thus received data into a format that is displayable for a terminal apparatus; and a terminal-end communication means for communicating with the terminal apparatus via a network so as to transmit the data thus converted into the format by the converting means.

3. A control server apparatus, being used in a control system including programmable display apparatuses (i) for acquiring contents of addresses of devices in accordance with screen data composed of a combination of (a) the addresses of the devices corresponding to displays displayed on regions on a screen, and (b) processing instruction words for indicating corresponding relationship between the

addresses of the devices and the regions on the screen, and (ii) for displaying the states of the devices on the regions on the screen in accordance with the contents, and comprising: a terminal-end communication means capable of communicating with a terminal apparatus; and a converting means for converting the screen data so as to generate a program for inquiring about the contents of the addresses to the terminal-end communication means, and for displaying the states of the devices according to how the terminal-end communication means responds, on one of screen regions of the terminal apparatus that corresponds to a screen region indicated by the screen data, the terminal-end communication means transmitting the program thus generated by the converting means, and acquiring the content of the address that the program is to inquire about, and transmitting to the terminal apparatus the content of the address.

5. The control server apparatus as set forth in claim 3, wherein: each programmable display apparatus includes (a) a designated protocol communication means for communicating with a control apparatus for controlling a device in a designated protocol that is designated to the control apparatus, (b) a common protocol communication means for communicating, regardless of which type the control apparatus is of, in a common protocol that is preset, and (c) a relay means for relaying communication in the designated protocol and communication in the common protocol by converting the protocols from one to the other, and the terminal-end communication means, when the addresses of the devices indicate which of the devices is to be controlled by the control apparatus, (i) transmits an inquiry that inquires the contents of the addresses, in the common protocol to that programmable display apparatus that is connected to the control apparatus, and (ii) acquires the contents of the addresses according to how the programmable display apparatus responds in the common protocol.

7. A control server apparatus, being used in a control system including programmable display apparatuses, in accordance with screen data composed of a combination of (a) addresses of devices corresponding to displays on regions on a screen, (b) addresses of devices corresponding to inputs entered onto the regions on the screen, and (c) processing instruction words for indicating corresponding relationship between the addresses and the regions of the screen, for changing, in response to the inputs, that contents of the addresses of the devices that correspond to the regions onto which the inputs are entered, and comprising: a terminal-end communication means capable of communicating with a terminal apparatus; and a converting means for converting the screen data so as to generate a program for giving an instruction to the terminal-end communication means, in response to an input entered onto a screen region of the terminal apparatus that is indicated by the screen data, the instruction for changing the contents of the addresses, the terminal-end communication means transmitting to the terminal apparatus the program generated by the converting means, and changing that contents of the addresses that are indicated by the instruction for changing the contents of the addresses.

9. The control server apparatus as set forth in claim 7, wherein: each programmable display apparatus includes (a) a designated protocol communication means for communicating with a control apparatus for controlling a device in a designated protocol that is designated to the control apparatus, (b) a common protocol communication means for communicating with the control apparatus, regardless of which type the control apparatus is of, in a common protocol that is preset, and (c) a relay means for relaying communication in the designated protocol and communication in the common protocol by converting the protocols from one to the other, and the terminal-end communication means, when the addresses of the devices indicate which device is to be controlled by the control apparatus, transmits to that programmable display apparatus that is connected with the control apparatus, an instruction for changing the contents of the addresses in the common protocol.

11. A control system comprising: programmable display apparatuses including (a) a

designated protocol communication means for communicating with a control apparatus for controlling a device in a designated protocol that is designated to the control apparatus, (b) a common protocol communication means for communicating, regardless of which type the control apparatus is of, in a common protocol that is preset, and (c) a relay means for relaying communication in the designated protocol and communication in the common protocol by converting the protocols from one to the other; and a control server apparatus including (d) a display apparatus-end communication means, connected to the programmable display apparatuses, for receiving data indicating screens of the programmable display apparatuses, (e) a converting means for converting the thus received data into a format that is displayable for a terminal apparatus, and (f) a terminal-end communication means for communicating with the terminal apparatus via a network so as to transmit the data that is converted into the format by the converting means.

12. A method of communicating comprising the steps of: (a) receiving data indicating a screen of a programmable display apparatus by a control server apparatus; (b) converting, into a format that is displayable for a terminal apparatus, the thus received data in the step (a); and (c) transmitting the data that is thus converted by communicating with the terminal apparatus via a network.

13. A recording medium storing a communication control program, the communication control program being for operating, as a control server apparatus, a computer, which is connected with a programmable display apparatus, and which includes a display apparatus-end communication means for receiving data indicating a screen of the programmable display apparatus, and a terminal-end communication means for communicating with a terminal apparatus via a network, wherein: the communication control program operates the computer as a converting means for converting, into a format that is displayable for a terminal apparatus, data received by the display apparatus-end communication means, and controls the terminal-end communication means to transmit the data that is thus converted by the converting means.

14. A control terminal apparatus, comprising: a wide area network communication means of being connected, via a wide area network, to a local control system including a control unit for controlling a control object in accordance with a control program, and a control display apparatus for communicating with the control unit via a serial interface so as to display or control a control state of the control unit; and a serial port simulating means for presetting which local control system having a control unit that is to receive the control program, and for receiving, as a proxy of a serial port, the control program which a control program generating means outputs to a serial port, and transmits, to the local control system, instruction data indicating the control program and the control unit to receive the control program, so as to instruct the wide area network communication means to give an instruction for updating the control program.

15. A control system comprising: a local control system including a control unit for controlling a control object in accordance with a control program, and a control display apparatus for displaying or controlling a control state of the control unit, the control display apparatus having (a) a designated protocol communication means for communicating via the serial interface in a designated protocol designated to a type of the control unit so as to display or control the control state of the control unit, (b) a common protocol communication means for communicating with a network other than the serial interface, regardless of which type the control apparatus is of, in a common protocol that is preset, and (c) a relay means for relaying communication between the designated protocol means and the common protocol means; and a control terminal apparatus including (d) a wide area network communication means capable of being connected, via a wide area network, and (e) a serial port simulating means (i) for presetting which local control system having a control unit that is to receive the control program, (ii) for receiving, as a proxy of a serial port, the control program which a control program generating means outputs to a serial port, and (iii) transmitting, to the

local control system, instruction data indicating the control program and the control unit to receive the control program, so as to instruct the wide area network communication means to give an instruction for updating the control program, the local control system including a display apparatus specifying means for specifying, via the wide area network, the control display apparatus connected to the control unit to receive the control program, in accordance with instruction data, which the local control system receives from the wide area network, and instructing, in the common protocol and via the network, the control display apparatus to update the control program.

16. A recording medium, storing therein a program for operating a computer as a control terminal apparatus including a control unit for controlling a control object in accordance with a control program, a wide area network communication means capable of being connected via a wide area network to a local control system having a control display apparatus for communicating with the control unit via a serial interface so as to display or control a control state of the control unit, the recording medium storing therein: a program for operating the computer as a serial port simulating means for presetting which local control system having a control unit that is to receive the control program, and for receiving, as a proxy of a serial port, the control program which a control program generating means outputs to a serial port, and transmits, to the local control system, instruction data indicating the control program and the control unit to receive the control program, so as to instruct the wide area network communication means to give an instruction for updating the control program.

17. A control system comprising: an acquiring means for displaying a state of a device on a display-use screen that has been generated in advance, and for acquiring screen data and device data from a control display apparatus for giving a control instruction for the device via the display-use screen, the screen data being for the display-use screen, and device data indicating a state of the device; a generating means for generating terminal-use data for displaying the display-use screen on a display surface of the terminal apparatus, in accordance with the screen data and device data thus acquired; and a communication means for communicating with the terminal apparatus via a network so as to transmit the terminal-use data to the terminal apparatus.

18. A control system comprising: a control display apparatus, which displays a state of device on a display-use screen that has been generated in advance, and which gives a control instruction to the device via the display-use screen, the control display apparatus including a recording means for storing therein screen data, which is data of the display-use screen, and a transmitting means for transmitting the screen data stored in the recording means in accordance with a request from a terminal apparatus; a communication means for acquiring, from the control display apparatus, device data indicating a state of the device, the communication means being capable of communicating with the terminal apparatus via a network; an execution program recording means for storing therein an execution program for causing the terminal apparatus to perform an action of inquiring the communication means about the device data corresponding to the screen data transmitted, and an action of displaying the display-use screen on the terminal apparatus in accordance with a response to the inquiring; and a generating means for generating terminal-use data for displaying the display-use screen on a display surface of the terminal apparatus, in accordance with the thus acquired screen data and the device data, the communication means transmitting the execution program and the terminal-use data to the terminal apparatus so as to cause the terminal apparatus to perform the actions, and acquiring device data that is inquired about by the terminal, so as to transmit the device data.

19. A computer readable recording medium, storing a control communication program for executing: an acquiring process for acquiring device data for displaying a state of a device on a display-use screen that has been generated in advance, and

for acquiring screen data and device data from a control display apparatus for giving a control instruction for the device via the display-use screen, the screen data being for the display-use screen, and device data indicating a state of the device; a generating process for generating terminal-use data for displaying the display-use screen on a display surface of the terminal apparatus, in accordance with the thus acquired screen data and the device data; and a communicating process for communicating with the terminal apparatus via a network so as to cause the terminal apparatus to transmit the terminal-use data.

20. A recording medium being readable for a computer for use in a control system including a control display apparatus, which displays a state of device on a display-use screen that has been generated in advance, and which gives a control instruction to the device via the display-use screen, the control display apparatus including a recording means for storing therein screen data for the display-use screen, and a transmitting means for transmitting the screen data stored in the recording means in accordance with a request from a terminal apparatus, the recording medium storing a program for executing: a communication process for acquiring, from the control display apparatus, a device data indicating the state of the device, and can communicate with the terminal apparatus via a network; an execution program recording process for causing the terminal apparatus to perform an action of inquiring the communication process about the device data corresponding to the screen data transmitted, and an action of displaying the display-use screen on the terminal apparatus in accordance with a response to the inquiring; and a generating process for generating terminal-use data for displaying the display-use screen on a display surface of the terminal apparatus, in accordance with the thus acquired screen data and the device data, the communication process transmitting the execution program and the terminal-use data to the terminal apparatus so as to cause the terminal apparatus to perform the actions, and acquiring device data that is inquired about by the terminal, so as to transmit the device data.

21. A control system, comprising: a control display apparatus for displaying a state of a device on a display-use screen that has been generated in advance, and for giving a control instruction for the device via the display-use screen; a server apparatus including a server-end communication means for acquiring device data from the control display apparatus, and for transmitting the device data, the device data indicating the state of the device; a plurality of terminal apparatuses including a terminal-end recording means for storing screen data in a format suitable for display processing, the screen data being for the display-use screen, a display processing means for inquiring the server-end communication means about whether or not the server-end communication means has acquired the device data corresponding the screen data stored in the terminal-end recording means, and for displaying the display-use screen in accordance with the device data transmitted from the server-end communication means, and a terminal-end communication means for communicating with the server-end communication means via a local network so as to receive the inquiry from the display processing means and the device data as a reply for the inquiry.

22. The control system as set forth in claim 21, wherein: the server apparatus includes a server-end storing means for storing the screen data in a format suitable for display processing, and a communication relay means for relaying communication between the server-end communication means and a public network, the server-end communication means acquiring the screen data stored in the server-end storing means and giving the screen data to the communication relay means, and the display processing means (a) inquires the server-end communication means, by relay communication via the relay means via the public network, about whether or not the server-end communication means has acquired the screen data stored in the server-end storing means and the device data corresponding thereto, and (b) displays the screen-use screen in accordance with (i) the screen data transmitted from the server-end communication means by the relay communication and (ii) the device data

corresponding thereto, (c) causes the server-end communication means to perform the communication via the local network for acquiring the screen data stored in the terminal-end storing means, and (d) causes the sever-end communication means to perform the communication via the public network for acquiring the screen data stored in the server-end storing means.

23. A recording medium storing therein a communication control program for causing a computer to execute: in a control system including (a) a control display apparatus for displaying a state of a device on a display-use screen generated in advance, and for giving, via the display-use screen, a control instruction for the device, (b) a sever apparatus having a sever communication means for acquiring, from the control display apparatus, display data indicating the state of the device, and for transmitting the device data, and (c) a plurality of terminal apparatuses for communicating with the server apparatus, a storing process for storing the screen data in a terminal-end storing means for storing screen data in a format suitable for display processing, the screen data being that data of display-use screen which the terminal apparatuses have; a display processing means for inquiring the sever-end communication means about whether or not the server-end communication means has acquired the device data corresponding to that screen data stored in the terminal-end storing means, which the terminal apparatuses have, and for displaying the display-use screen in accordance with the device data transmitted from the server-end communication means; and a terminal-end communication means for communicating, via a local network, with the server-end communication means so as to receive the inquiry from the display processing means and the device data as a reply thereto.

24. The recording medium as set forth in claim 23, further comprising: a sever-end storing means for storing therein the screen data in a format suitable for display processing; and a communication relay means for relaying communication between the server-end communication means and a public network, the server-end communication means acquiring the screen data stored in the server-end storing means, and the communication control program causing the computer to perform the storing processing for storing the screen data in the server-end storing means in the server apparatus for giving the screen data to the communication relay means, and in the server-end storing means, the display processing means (a) inquiring the server-end communication means, by relay communication via the relay means via the public network, about whether or not the server-end communication means has acquired the screen data stored in the server-end storing means and the device data corresponding thereto, and (b) displaying the screen-use screen in accordance with the screen data transmitted from the server-end communication means and the device data corresponding thereto by the relay communication, (c) causing the server-end communication means to perform the communication via the local network for acquiring the screen data stored in the terminal-end storing means, and (d) causing the sever-end network to perform the communication via the public network for acquiring the screen data stored in the server-end storing means.

25. A control system for accumulating data regarding a control apparatus to which an input apparatus and an output apparatus are connected, by communication, via a designated network in a communication protocol designated to the control apparatus, between the control apparatus and display-type control apparatuses, which display control states of the input and the output apparatus caused by the control apparatus, and which give a control instruction to the control apparatus, and by communication, via a common network in a common communication protocol, between a host computer provided ranking above the display-type control apparatus, and at least one of the display-type control apparatuses, wherein: the display-type control apparatus includes: a protocol converting means for converting the communication protocols used in both the networks from one to the other; and a delivery means for delivering to the host computer, a user program for displays a control states of the control apparatus, the user program being executed when a preset delivery condition is satisfied, respective change elements, which are

corresponded to addresses of the input and the output apparatus in the user program, and which are changed in accordance with data of the control instruction and the output data resulted from the control instruction data, and the control instruction data and the output data corresponding to the change elements, and the host computer includes: an accumulating means for accumulating the user program, the change elements, and both the data, which are thus delivered, sequentially in time sequence and per the display-type control apparatus; a searching means for consecutively searching and displaying the user program, the change elements and both the data accumulated in the accumulating means; a converting means for converting, into an execution program executable for a terminal apparatus, the user program searched out by the searching means as requested by the terminal apparatus; and a communicating means for transmitting the execution programs, the change elements, and both the data to the terminal apparatus that executes the execution program, so as to change the change elements in the user program in accordance with both the data.

26. A data accumulating method, including the step of accumulating data regarding a control apparatus to which an input apparatus and an output apparatus are connected, by communication, via a designated network in a communication protocol designated to the control apparatus, between the control apparatus and display-type control apparatuses, which display control states of the input and the output apparatus caused by the control apparatus, and which give a control instruction to the control apparatus, and by communication, via a common network in a common communication protocol, between a host computer provided ranking above the display-type control apparatus, and at least one of the display-type control apparatuses, the data accumulating method comprising the steps of: causing the display-type control apparatus (a) to convert the communication protocols used in both the network from one to the other, and (b) to deliver to the host computer, a user program for displays a control states of the control apparatus, the user program being executed when a preset delivery condition is satisfied, respective change elements, which are corresponded to addresses of the input and the output apparatus in the user program, and which are changed in accordance with data of the control instruction and the output data resulted from the control instruction data, and the control instruction data and the output data corresponding to the change elements; accumulating the user program, the change elements, and both the data, which are thus delivered to the host computer, sequentially in time sequence and per the display-type control apparatus; consecutively searching and displaying the user program, the change elements and both the data accumulated in the accumulating means; converting, into an execution program executable for a terminal apparatus, the user program searched out by the searching means as requested by the terminal apparatus; and transmitting the execution programs, the change elements, and both the data to the terminal apparatus that executes the execution program, so as to change the change elements in the user program in accordance with both the data.

27. A computer-readable recording medium storing therein a program for accumulating data regarding a control apparatus to which an input apparatus and an output apparatus are connected, by communication, via a designated network in a communication protocol designated to the control apparatus, between the control apparatus and display-type control apparatuses, which display control states of the input and the output apparatus caused by the control apparatus, and which give a control instruction to the control apparatus, and by communication, via a common network in a common communication protocol, between a host computer provided ranking above the display-type control apparatuses, and at least one of the display-type control apparatuses, the recording medium storing therein the program for executing: a process for causing the display-type control apparatuses (a) to convert the communication protocols used in both the networks from one to the other, and (b) to deliver to the host computer, (i) a user program for displays a control states of the control apparatus, the user program being executed when a preset delivery condition is satisfied, (ii) respective change elements, which are corresponded to addresses of the input and the output apparatus, and which are

changed in accordance with data of the control instruction and the output data resulted from the control instruction data, and (iii) the control instruction data (iv) the output data, the control instruction data and the output data corresponding to the change elements; a process for accumulating the user program, the change elements, and both the data, which are thus delivered, sequentially in time sequence and per the display-type control apparatus; a process for consecutively searching and displaying the user program, the change elements and both the data accumulated in the accumulating means; a process for converting, into an execution program executable for a terminal apparatus, the user program searched out by the searching means as requested by the terminal apparatus; and a process for transmitting the execution programs, the change elements, and both the data to the terminal apparatus that executes the execution program, so as to change the change elements in the user program in accordance with both the data.